A
COMPEND
OF
PHYSICS.

Non fingendum aut excogitandum ſed inveniendum, quid Natura faciat aut ferat. BACON.

GLASGOW:
PRINTED BY ROBERT AND ANDREW FOULIS
FOR T. CADEL IN LONDON, AND
JOHN BALFOUR IN EDINBURGH,
M.DCC.LXX.

PREFACE.

Tho no fact is more certain, or more obvious, than that we know nothing of the Material World, but by our own experience, or by the experience of others aſcertained to us by teſtimony, yet it is well known how long it was before the writers in Phyſics could be convinced of this; and how apt they ſtill are to forget it in their theories. The reaſon is plain. Ignorance of facts, or a ſuperficial attention to them, renders it eaſy for any one of a good imagination to make a theory; and a theory is pleaſing to the vanity of its Author. Hence the great numbers which have been formed in all learned countries, and hence their manifold contradictions to each other. But Experiments require time, labour, patience, expence, candour, and attention; and the beſt theories founded on them afford difficulties enow to humble the arrogance of the human underſtanding. It is now to be hoped that in our age and country, there are few who conſider the moſt elaborate theories, if not ſupported by facts, as the works of Philoſophy.

This little volume contains nothing but the General Heads of an annual Courſe of Lectures in the Univerſity of Glaſgow; together with the concluſions which reſult from Experiments performed at the ſame time. Theſe concluſions are expreſſed in the Synthetic form of Propoſitions and Corollaries, ſo that every Propoſition is like an Enunciation in Euclid, and the Experiments are exhibited as the proof. The Experiments however by which ſome of the Propoſitions are proved cannot be performed in a ſmall place, or in a ſhort time; in which caſe they are minutely deſcribed, which is all that can be done. In Aſtronomy particularly, it is obvious, that deſcriptions by the help of machines muſt ſupply the place of Experiments; excepting when the obſervatory and teleſcopes &c. are uſed for that purpoſe, which they annually are.

In the firſt part, or Somatiology*, Bodies of every kind are claſſed according to the ſecondary particles of matter, without regard to external forms, or to the different kingdoms of nature. The claſſes, orders, diviſions, and ſubdiviſions are not a few; but it would ſeem that they cannot be reduced to a ſmaller number, without giving up preciſion in arrangement, or aſcribing qualities to bodies, which our preſent Experiments do not ſupport. Short characters are given of them, and of a few of the genera. The moſt remarkable component parts of the reſt are printed in Italics upon the right and left hand ſide of the Names.

In the fifth part, Foſſils are claſſed according to the Method laid down in the firſt; and the ſpecies are added under every genus, according to their denſities, colours, or hardneſs.

That all bodies are compoſed of a few kinds of elementary particles, is one of the moſt ancient doctrines in Philoſophy; and yet it is only of late that attempts have been made to arrange Foſſils according to the elements they contain. The common method has been, to claſs them according to their external appearances; a method tedious and inaccurate, becauſe a multitude of external marks are neceſſary to diſtinguiſh the greateſt part, while ſome have the ſame properties with different appearances, and others the ſame appearances with different properties. The elementary method is ſimple and fixed, provided the degree of fire is aſcertained; while all others not founded upon this method, have been varied, and may be varied without end. It muſt be remembred however, that there are few Foſſils which are not compounds, and conſequently that they may be placed in this or that Claſs according to the parts of which they are compoſed. To repeat them in every claſs, to which ſome of their conſtituent parts belong, would be an unneceſſary, and often an almoſt endleſs taſk; but ſuch as are remarkably heterogeneous are ſometimes repeated without a number, which will ſhew that they are claſſed in a more natural place.

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* Σωμάτιον. Corpuſculum—Eo ſenſu quo multitudo aliqua ſedes conjunctas habens. STEPH.

In order to obviate an objection which may be made to this Method, even by ſuch as adopt the ſame principles, it may be proper to obſerve that the Saxa and Mineralia Larvata cannot be excluded; for what ſhould we think of a ſyſtem in any other branch of ſcience which required an Appendix? Would not the very name declare that the ſyſtem was imperfect? Tho Scoriae therefore are Bodies which are in a different ſtate from what they once were, tho Wood and ſome Moulds belong to the vegetable, and Shells, Animals, and Lithophyta, to the animal kingdom, yet the Changes upon them were not produced by art, and therefore they are Foſſils in the juſteſt ſenſe.

In conformity to cuſtom, a liſt is given of the moſt noted of the figured Stones. To enumerate them all would be as difficult, and as uſeleſs, as to arrange the clouds.

Perhaps this plan of Mineralogy may pleaſe all parties, for it takes in both methods of arrangement, it is ſimple, and is attended with this conveniency, that one may eaſily ſee what Bodies are produced by nature, and what by art.

The various ways of combining and ſeparating bodies, and a minute arrangement of vegetables, as of foſſils, belong not to the author's province.

Sexual differences, and fixt external marks render it much more eaſy to claſs the ſecond and third, than the firſt, of the kingdoms of nature. Even an improvement will not always juſtify the change of a Method which is generally received.

Some Zoologiſts content themſelves with diffuſe and indeterminate deſcriptions, ſo that their method is as little ſcientific as that of the Mineralogiſts abovementioned. Others imagine that all claſſing is as arbitrary as the whimſical arrangement which any one may give to the particles in a heap of ſand. They conſider not that the time of geſtation, or the progeny's being mules, fix the genera with as much preciſion as the elementary particles do in Mineralogy, and that when theſe characters cannot be got, Anatomy furniſhes others which are equally diſtinct. A third ſort aim little at ſcientific marks, but change arrangements in order to render them more elegant, or more natural in their opinion. They obſerve not, that all who do ſo in any of the three kingdoms of nature, muſt be viewed in the ſame light with that librarian who boaſted of having done great ſervice to learning, becauſe he had changed the ſhelves and places of his books.

By the numbers in Mineralogy and Zoology, all the ſpecimens in the Phyſical Apparatus Room may be eaſily found; and it is proper to obſerve, that, in order to ſave printing, when a ſpecies has the ſame name with its genus, Communis or Vulgaris is underſtood; and that in many caſes the adjective is only added to the number. Thus for inſtance, in Part I. Claſs III. Order II. Genus II. Sulphuris Minera, it is, Species 3. Pyrites Chalybeus. Species 4. Granulatus, inſtead of, Pyrites Granulatus. And in Part III. Claſs VI. Order I. Diviſion XII. Genus I. Certhia, it is, Species 3. Muralis, inſtead of, Certhia Muralis; and this too is the caſe with regard to major and minor, the different colours, and the names of countries.

It is often difficult, and ſometimes impoſſible to find Engliſh Words which correſpond exactly to the Greek and Latin Terms uſed by the writers in Phyſics. It is extremely uſeful for a Student to be made acquainted with the terms that have been employed by ſtandard authors; and a variety of them is ſometimes uſed for this very purpoſe. Theſe reaſons, it is hoped, will be a good apology for the impropriety of mixing together the words of different languages; and the terms uſed in Philoſophy and in common life. Many late writers ſeem as fond of making new names, as if there was ſome merit in contriving Words, and in encreaſing the diſagreeable part of Science. So much care has been taken to avoid this in the following ſheets, that there are but two new Words in the whole. Neceſſity produced them, and their meaning is very obvious.

The mathematical parts of Natural Philoſophy, with the hiſtory and tenets of the different ſects, both ancient and modern, are taught by the author at a ſeparate Lecture; and ſo as to refer to the courſe of Experiments and Lectures, of which this is a Compend.

INTRODUCTION.

OF Experimental Philoſophy. The inducements to purſue it from curioſity, the love of beauty, truth, and grandeur; from the advantages it brings to human life, by the improvement of arts, machines, and manufactures; and from the manifold proofs it gives of wiſdom, power, and goodneſs in the creation.

Of the proper method of making experiments, and of the concluſions to be drawn from them, commonly called the rules of philoſophizing.

Of the principal perſons who have improved this uſeful ſcience.

Of the parts into which it is divided; and the reaſons of the following arrangement.

PART. I. SOMATIOLOGY.

II. ELECTRICITY.

III. MAGNETISM.

IV. GRAVITATION.

V. NATURAL HISTORY.

VI. MECHANICS.

VII. HYDROSTATICS.

VIII. PNEUMATICS.

IX. OPTICS.

X. ASTRONOMY.

SOMATIOLOGY.

SECT. I.

Of ſpace, matter, and motion.

PROP. I.

SPACE is extended, but is not moveable, or ſolid, as matter is.

PROP. II.

Matter is extended, moveable, ſolid, and inert.

PROP. III.

Space and motion are abſolute or relative. Matter may be abſolutely in motion, and relatively at reſt; or abſolutely at reſt, and relatively in motion.

SECT. II.

Of ſpace void of matter.

PROP. I.

The denſeſt maſſes of matter are full of pores.

PROP. II.

There are maſſes of matter, or bodies, of the ſame bulk, and of unequal weights.

PROP. III.

If bodies of the ſame bulk and unequal weights are let fall in the air, the lighteſt will be ſenſibly retarded; but in a place where there is no air, all bodies however differing in weight, bulk, or ſhape, fall from the ſame heights with equal velocities.

Proofs from theſe experiments that all ſpace is not replete with matter.

Of other proofs of a vacuum.

SECT. III.

Of the ideal diviſibility of matter.

PROP. I.

Every piece of matter may be divided by the mind into a number of parts greater than any that can be aſſigned.

Cor. This too is the property of ſpace.

SECT. IV.

Of the actual diviſibility of matter.

PROP. I.

One grain of gold may eaſily be divided into two millions of parts; and a cubic inch into nine billions five hundred and twenty three millions, eight hundred and nine thouſand, and five hundred and twenty-three parts, each of which may be diſtinctly ſeen by the naked eye.

PROP. II.

A particle of ſand, ſo ſmall that a million of ſuch

particles may be contained in a cubic inch, does contain two millions, an hundred and eleven thouſand, and four hundred ſuch parts as a ſingle grain of copper may be divided into, and yet be viſible by the naked eye.

PROP. III.

If an inch were divided into a trillion of parts, the particles of ſome odoriferous bodies are leſs in bulk than thirty-eight of theſe parts.

PROP. IV.

If the fluids in animalcula and men are in the ſame proportion to their reſpective bodies, a ſpace equal in bulk to the ſmalleſt grain of ſand that is viſible by the naked eye, would contain more of the globules of ſome of the fluids in animalcula, than a ſpace equal in bulk to two hundred and ſixty-ſix of the higheſt mountains in the earth would contain grains of ſand.

Of other proofs of the actual diviſibility of matter.

SECT. V.

Of the primary particles of matter.

PROP. I.

All bodies however different in qualities or forms, conſiſt of a few kinds of unchangeable particles variouſly combined together.

Of the commonly ſuppoſed elements.

Earth. Water. Air. Fire.

PROP. II.

The commonly ſuppoſed elements are not atoms.

They ſeem to conſiſt of many parts; ſo that the original elements are not known, and perhaps are very few in number.

Of the difficulty of reducing bodies to their firſt principles, atoms, or primary particles.

SECT. VI.

Of the ſecondary particles of matter.

PROP. I.

Matter under every form produced by the operations of nature or art, that we are acquainted with, may be arranged in the following manner.

CLASS I.

SALINE BODIES.

ORDER I.

SIMPLE SALTS.

DIVISION I.

ACIDS.

Genus.

1. Vitriolic Acid.
2. Nitrous Acid.
3. Muriatic Acid.

Genus.

4. Vegetable Acid.
5. Animal Acid.
6. Phoſphorine Acid.

DIVISION II.

ALKALIS.

SUBDIVIS. 1.

Fixt Alkalis.

Genus. *Genus.*
1. Foſſil Fixt Alkali. 2. Vegetable Fixt Alkali.

SUBDIVIS. 2.

Volatile Alkali.

Genus.
1. Alkali Volatile.

ORDER II.

COMPOUND SALTS.

DIVISION I.

NEUTRAL SALTS.

	Genus.	
Vit. Acid.	1. Vitriolated Tartar.	*Veg. Alk.*
Vit. Acid.	2. Glauber's Salt. §	*Foſſ. Alk.*
Vit. Acid.	3. Vitriolic Ammoniac.	*Vol. Alk.*
Nit. Acid.	4. Common Nitre.	*Veg. Alk.*
Nit. Acid.	5. Cubic Nitre.	*Foſſ. Alk.*
Nit. Acid.	6. Nitrous Ammoniac.	*Vol. Alk.*

§ These diffe
compositions a
made from
the Acids &
Alkalis
in States —

Genus.		
Mur. Acid.	7. Sal digeſt. Silvii.	*Veg. Alk.*
Mur. Acid.	8. Common Salt.	*Foſſ. Alk.*
Mur. Acid.	9. Com. Salt Ammoniac.	*Vol. Alk.*
Veg. Acid.	10. Regenerated Tartar.	*Veg. Alk.*
Veg. Acid.	11. Polychreſt of Rochelle.	*Foſſ. Alk.*
Veg. Acid.	12. Spiritus Mindereri.	*Vol. Alk.*
Mur. Acid.	13. Sedative Salt.	*Phlog.* (*incert.*)
Sal Sedativ.	14. Borax.	*Foſſ. Alk.*

DIVISION II.

EARTHY SALTS.

Genus.		
Vit. Acid.	1. Gypſa.	*Ter. calc.*
Vit. Acid.	2. Sal cathart. amar.	*Magneſia.*
Vit. Acid.	3. Alumen.	*Argilla.*
Vit. Acid.	4. Minera Aluminis.	*Argil.* &c.
Mur. Acid.	5. Sal Ammon. Fixum.	*Ter. calc.*

DIVISION III.

METALLIC SALTS.

Genus.		
Vit. Acid.	1. Turpethum minerale.	*Hydrarg.*
Vit. Acid.	2. Vitriolum coeruleum.	*Cuprum.*

. *Alk.*
. Alk.
. *Alk.*

. *Alk.*
. Alk.
. Alk.

og.(*incert.*)
. Alk.

er. calc.
agneſia.
rgilla.
rgil. &c.
er. calc.

ydrarg.
uprum.

Genus.		
Vit. Acid.	3. Vitriolum viride.	*Ferrum.*
Vit. Acid.	4. Vitriolum album.	*Zincum.*
Nit. Acid.	5. Cauſticum lunare.	*Argentum.*
Nit. Acid.	6. Mercurii ſolutio.	*Hydrarg.*
Nit. Acid.	7. Veneris ſolutio.	*Cuprum.*
Nit. Acid.	8. Saturni ſolutio.	*Plumbum.*
Nit. Acid.	9. Martis ſolutio.	*Ferrum.*
Nit. Acid.	10. Cobalti ſolutio.	*Cobaltum.*
Nit. Acid.	11. Zinci ſolutio.	*Zincum.*
Nit. Acid.	12. Nickeli ſolutio.	*Nickelum.*
Mur. Acid.	13. Luna cornea.	*Argentum.*
Mur. Acid.	14. Mercurius corroſivus.	*Hydrarg.*
Mur. Acid.	15. Saturnus corneus.	*Plumbum.*
Mur. Acid.	16. Atrament. ſympath.	*Cobaltum.*
Veg. Acid.	17. Aerugo.	*Cuprum.*
Veg. Acid.	18. Saccharum Saturni.	*Plumbum.*

ORDER III.

SALINE PETREFACTIONS.

Genus.		
Salia.	1. Petrefacta vegetabilia.	*Veg. vel part. veg.*
Salia.	2. Petrefacta animalia.	*Anim. vel partes.*

CLASS II.

EARTHY BODIES.

ORDER I.

HOMOGENEOUS EARTHS.

DIVISION I.

ABSORBENT EARTHS.

SUBDIVIS. I.

Calcarea.

	Genus.	
Ter. Calc.	1. Terra Calcarea.	*Aer. Fix.*
Ter. Calc.	2. Teſtacea.	*Idem.*
Ter. Calc.	3. Lithophita.	*Ol. Anim.*
Ter. Calc.	4. Gypſa.	*Vitr. Acid.*
Ter. Calc.	5. Sal Ammon. Fixum.	*Mur. Acid.*
Ter. Calc.	6. Oſteocolla.	*Ter. Cryſt.*
Ter. Calc.	7. Lapis ſuillus.	*Phlogiſton.*
Ter. Calc.	8. Lapis hepaticus.	*Phl. Vit. Ac.*
Ter. Calc.	9. Marga.	*Argilla.*
Ter. Calc.	10. Min. ferri alba.	*Ferrum.*
Ter. Calc.	11. Coeruleum mont.	*Cuprum.*
Ter. Calc.	12. Ceruſſa nativa.	*Plumbum.*

H S.

r. Fix.
m.
Anim.
r. Acid.
ur. Acid.
r. Cryſt.
logiſton.
l. Vit. Ac.
gilla.
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prum.
umbum.

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SUBDIVIS. 2.

Magneſia.

Genus.		
Magneſia.	1. Terra vegetabil. exuſtor.	
Magneſia.	2. Sal cathartic. amar.	*Vitr. Acid.*

SUBDIVIS. 3.

Aluminous-Earth.

Genus.		
Argilla.	1. Alumen.	*Vitr. Acid.*
Argilla.	2. Minera aluminis.	*Idem, et corp. heterog.*

SUBDIVIS. 4.

Bone-Earth.

Genus.		
Terra (*incert.*)	1. Cineres oſſ. corn.	*Liq. inſip.*

SUBDIVIS. 5.

Fleſh-Earth.

Genus.		
Terra (*incert.*)	1. Cineres ſang. carn.	*Liq. aſtring.*

DIVISION II.

CRYSTALLINE-EARTH.

Genus.		
Ter. Cryſt.	1. Corpora cryſtal.	*Metal. Phlog.* (*incert.*)

Genus.		
Ter. Cryſt.	2. Petrefacta cryſt.	*Part. veg.* (*incert.*)

DIVISION III.

GRANATE-EARTH.

Genus.		
Ter. Gran.	1. Granatus Martialis.	*Ferrum.*
Ter. Gran.	2. Granatus Jovis.	*Fer. et Stan.*
Ter. Gran.	3. Granatus Saturni.	*Fer. et Plumb.*
Ter. Gran.	4. Baſaltes.	*Fer.* (*incert.*)

DIVISION IV.

ARGILLACEOUS-EARTH.

Genus.		
Argilla.	1. Argil. communis.	*Vitr. Acid. et ſer.*
Argilla.	2. Argilla apyra.	*Phlogiſton.*
Argilla.	3. Argilla vitreſcens.	*Phlog.* (*incert.*)
Argilla.	4. Argilla ferrea.	*Ferrum.*
Argilla.	5. Petrefacta argillacea.	*Partes veget.*

DIVISION V.

MICACEOUS-EARTH.

Genus.		
Ter. Mic.	1. Venice talc.	*Argil.* (*incert.*)

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Genus.		
Ter. Mic.	2. Solar talc.	*Ferrum.*

DIVISION VI.

FLUOR-EARTH.

Genus.		
Ter. fluor min.	1. Fluor mineralis.	*Phlog.* (*incert.*)

DIVISION VII.

ASBESTINE-EARTH.

Genus.		
Ter. Asbes.	1. Asbeſtus.	*Argil.* (*incert.*)

DIVISION VIII.

ZEOLITE-EARTH.

Genus.		
Ter. Zeol.	1. Zeolites purus.	(*Incert.*)
Ter. Zeol.	2. Lapis lazuli.	*Fer. Arg.*(*incert.*)

DIVISION IX.

MANGANESE-EARTH.

Genus.		
Ter. Mang.	1. Manganeſia pura.	(*Incert.*)
Ter. Mang.	2. Manganeſia atra.	*Ferrum.*
Ter. Mang.	3. Spuma lupi.	*Ter. Stan.*

ORDER II.

HETEROGENEOUS EARTHS.

DIVISION I.

CLOSE-GRAINED.

	Genus.	
Ter. Calc.	1. Ophites.	*Ter. argil.*
Quartz.	2. Stellſten.	*Mica.*
Quartz.	3. Norca.	*Mica. et granat.*
Quartz.	4. Whetſtone.	*Mica. et argil.*
Steatites.	5. Telgſten.	*Mica.*
Jaſp. et Spat.	6. Porphyry.	*Mica et Baſaltes.*
Jaſp. et Fer.	7. Trapp.	*Argil.* (*incert.*)
Jaſp. Mart.	8. Amygdaloides.	*Fer. Spat. et calc.*
Mica.	9. Gronſten.	*Hornblende.*
Spat. et Mic.	10. Granite.	*Quartz. ſteat.* &c.

DIVISION II.

GRANULOUS.

	Genus.	
Ter. conglut.	1. Free-ſtone.	*Calc. Quartz. Mic.* &c.
(*Incert.*)	2. Breccia.	*Frag. Lapid.*

DIVISION III.

SCORIAE.

	Genus.	
Glaſs ſlag.	1. Iceland agate.	*Fer.* (*incert.*)

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Genus.		
Glaſs ſlag.	2. Rhine milnſtone.	(*Incert.*)
Glaſs ſlag.	3. Pumice ſtone.	(*Incert.*)
Glaſs ſlag.	4. Pearl ſlag.	*Ciner vulcan.*
Glaſs ſlag.	5. Lava.	*Ciner vulcan.*

DIVISION IV.

MOULDS.

Genus.		
Ter. Argil.	1. Humus vegetabilis.	*Vegetab. putrida.*
Ter. Argil.	2. Humus animalis.	*Anim. putrida.*

CLASS III.

INFLAMMABLE BODIES.

ORDER I.

PHLOGISTON.

Genus.		
Ignis.	1. Pure inflammable matter.	(*Incert.*)

ORDER II.

SULPHUR.

Genus.		
Phlogiſton.	1. Sulphur purum.	*Vitr. acid.*
Sulphur.	2. Sulphuris minera.	*Foſſilia.*

ORDER III.

CHARCOAL.

Genus.

Phlogiſton.	1. Carbo Lignarius.	*Ter. alk.*

ORDER IV.

ARDENT SPIRIT.

Genus.

Phlogiſton.	1. Spiritus ardens.	*Aqua.*
Phlog. et acid.	2. Aether.	*Minus aquae.*

ORDER V.

OIL.

DIVISION I.

FOSSIL OIL.

Genus.

Foſſ. oil.	1. Naphta.	
Foſſ. oil.	2. Petroleum.	*Corp. heterog.*
Foſſ. oil.	3. Bitumen.	*Ter. alk.*
Foſſ. oil.	4. Jett.	*Partes ligneae.*
Foſſ. oil.	5. Foetid-peat.	*Vegetabilia.*
Foſſ. oil.	6. Pit-coal.	*Sulph. alumen.*
Foſſ. oil.	7. Amber.	*Vitr. et mur. acid.*

DIVISION II.

VEGETABLE OIL.

SUBDIVIS. 1.

Expreſſed Vegetable Oil.

Genus.		
Ol. veg.	1. Oleum veg. viſcidum.	*Sine part. veg.*

SUBDIVIS. 2.

Eſſential Vegetable Oil.

Genus.		
Ol. veg.	1. Oleum veg. ſubtile.	*Partic. odor.*

Of Empyreumatic Vegetable Oil.

Of Gums. Reſins. Sugar. Camphor.

DIVISION III.

ANIMAL OIL.

SUBDIVIS. 1.

Expreſſed Animal Oil.

Genus.		
Ol. anim.	1. Ol. anim. aedipoſum.	*Acid. anim.*

SUBDIVIS. 2.

Eſſential Animal Oil.

Genus.		
Ol. anim.	1. Ol. anim. eſſentiale.	*Alkali vol.*

Of Empyreumatic Animal Oil.

Of Milk, Gall, Faeces, Unctuous, and Gelatinous Animal Subſtances.

ORDER VI.

PHOSPHORUS.

	Genus.	
Phoſ. acid. oil.	1. Kraft's phoſ. urinae.	*Mur. ac. alk.*
Idem.	2. Margraff's phoſ. veg.	*Idem.*
Alum.	3. Homberg's phoſ.	*Phlogiſton.*

Of Noctilucae.

Foſſil.

Gypſeous Earths. Nitrous Acid and Chalk. Fixt Sal Ammoniac. Calx viva et Sulphur. Multa corpora in fuſione. Adamas luce ſaturatus.

Vegetable.

Lignum putridum. Folia nonnulla.

Animal.

Piſces putridae. Caro putrida. Inſectae marinae. Cicindela. Oculi anim. nonnul. Panni nonnulli.

Of Electrical Noctilucae, and Meteors.

Of inflammable Air. Mineral. Vegetable. Animal.

Of Woods.

CLASS IV.

METALLIC BODIES.

DIVISION I.

METALS.

Perfect.

Genus.

1. Gold.
2. Platina.
3. Mercury.
4. Silver.

Imperfect.

Genus.

5. Lead.
6. Copper.
7. Iron.
8. Tin.

DIVISION II.

SEMI-METALS.

Genus.

1. Biſmuth.
2. Nickel.
3. Zinc.

Genus.

4. Regulus Antimonii.
5. Regulus Arſenici.
6. Regulus Cobalti.

DIVISION III.

ORES.

SUBDIVIS. I.

Metallic Ore.

Genus.

1. Minera Auri.

Genus.

2. Minera Platinae.

Genus.

3. Minera Mercurii.
4. Minera Argenti.
5. Minera Plumbi.

Genus.

6. Minera Cupri.
7. Minera Ferri.
8. Minera Stanni.

SUBDIVIS. 2.

Semi-Metallic Ore.

Genus.

1. Minera Biſmuthi.
2. Minera Nickeli.
3. Minera Zinci.

Genus.

4. Minera Antimonii.
5. Minera Arſenici.
6. Minera Cobalti.

CLASS V.

WATER.

DIVISION I.

SIMPLE WATER.

Genus.

1. Aerial Water.

Genus.

2. Terreſtrial Water.

DIVISION II.

COMPOUND WATER.

SUBDIVIS. I.

Saline Water.

Genus.

1. Acid Water.
2. Alkaline Water.
3. Nitrous Water.

Genus.

4. Sea Water.
5. Salt Spring Water.

SUBDIVIS. 2.

Earthy Water.

Genus.
1. Saline Earthy.

Genus.
2. Calcareous.

SUBDIVIS. 3.

Phlogiſtic Water.

Genus.
1. Sulphureous Alcaline.
2. Sulphureous Glauber.
3. Sulphureous Sea Salt.

Genus.
4. Sulphureous Calcar.
5. Oily.

SUBDIVIS. 4.

Metallic Water.

Genus.
1. Cupreous.

Genus.
2. Ferruginous.

CLASS VI.

AIR.

DIVISION I.

COMMON AIR.

Genus.
1. Pure Com. Air.
Aer Pur. 2. Mixed Com. Air. *Corp. heterog.*

DIVISION II.

FACTITIOUS AIR.

Var.	*Var.*
1. Mephitic.	5. Zumotic.
2. Aduſt.	6. Salalkaline.
3. Pulmonic.	7. Terrabſorbent.
4. Stillatitious.	

CLASS VII.

FIRE.

Spec.

1. Fire producing heat.
2. Fire producing light.
3. Fire producing heat and light.
4. Latent fire.
5. Fire with ſome Electrical Phaenomena.

CHARACTERS.

Of the above Claſſes, Orders, Diviſions, and Subdiviſions; and of ſome of the Genera.

CLASS I.

Such bodies as are ſaltiſh to the taſte, and ſoluble in water.

ORDER I.

Such as cannot be decompoſed by the common ope-

rations of art; or all the component parts of which cannot be aſcertained.

DIVISION I.

Have a ſour taſte, and give a red tinge to moſt of the blue juices of vegetables.

Genus 1.

When pure is without ſmell, without colour, and in weight to water, of the ſame bulk, as 18.775 to 10.000. Unites with water, and efferveſces. May be more than doubled in weight by the water which it imbibes from the air. Is not volatile. Has different appearances according to its purity, and the nature of the bodies with which it is mixed. Acts upon alkalis, earths, inflammable, metallic, vegetable, and animal bodies; and produces compounds, which have various properties, and forms when cryſtallized.

Genus 2.

Is eaſily diſtinguiſhed from the laſt by the following properties. Has a peculiar ſmell. Exhales perpetually in vapours. Is of a fiery yellow colour. Imbibes leſs water from the air. And when ſtrong is in weight to water as more than one and an half to one.

Genus 3.

Gives a weak ſaffron like ſmell, which is eaſily diſtinguiſhed from that of the other acids. Is of a whitiſh colour. Is in weight to water as 13 to 10. Unites with water, but not ſo much as the vitriolic acid. When very pure diſſolves tin and lead; when leſs ſo, copper, iron, zinc, and the regulus of antimony. Mixed with the nitrous acid makes aqua regia. Unites with ſilver diſſolved in aqua fortis, and with lead in aqua regia, falling with them to the bottom in a white ſpongy maſs.

Genus 4.

Is procured from vegetables. Has a well known ſmell. Is clear, and is in weight to water as 1.011 to 1.000. Acts not upon gold, platina, mercury, or ſilver. Corrodes copper, zinc, and lead. Is not ſo ſimple, fixed, and capable of being concentrated as the mineral acids.

Genus 5.

Has many of the properties of the marine acid, and a great analogy with the vegetable; but does not precipitate ſilver, lead, or mercury from the nitrous acid; nor quick-lime from the marine: does not act upon filings of ſilver; but when heated, totally diſſolves the calx of ſilver, if precipitated from aqua fortis by ſalt of tartar: does not diſſolve the calx of mercury, but turns it into fluid mercury. Acts weakly upon filings of copper, but perfectly diſſolves copper that has been calcined; diſſolves iron filings with violence: ſcarcely acts upon the filings or calces of tin, or of biſmuth, or of regulus of antimony: diſſolves zinc with violence, and ſhoots into cryſtals unlike thoſe produced by the vegetable acid.

Genus 6.

The moſt fixed of all the acids. Sometimes in the

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fire puts on the appearance of glaſs. When ſaturated with alkaline ſalt, ſhoots into cryſtals, which do not crepitate like ſea-ſalt, and which have a glaſſy appearance. Perfectly diſſolves zinc, iron, calx of copper and white arſenic. Partly diſſolves lead, copper, and tin filings, and upon ſilver and gold has no effect at all. When mixed with a ſolution of gold, occaſions no precipitation. Precipitates ſilver when diſſolved in the volatile alkali, with a yellow colour; and when the alkali is impregnated with an animal inflammable matter, with a red colour. Precipitates mercury in aqua fortis; but on ſtanding, the greateſt part is taken up again. Precipitates a ſolution of lead in aqua fortis, but on ſtanding it is not rediſſolved.

DIVISION II.

Have a pungent acrid taſte very different from that of acids: and make the blue juice of vegetables green.

SUBDIVIS. I.

Require an intenſe heat to diſſipate them.

Genus I.

Unites with acids, and forms neutral ſalts. Unites with oils, and gives them the property of mixing with water. By being mixed with them, forms ſoap. Imbibes moiſture from the air, and becomes fluid and cauſtic. In a ſolid cryſtallized ſtate, is mild. When mild, efferveſces with acids. Shoots into cryſtals of a priſmatical figure which fall in the air. Is fuſible in a moderate degree of fire. Serves to fuſe all the earths.

In a certain degree of fire melts with the earths into a glaſs. In a great proportion communicates its properties to the earths which it has diſſolved. Unites perfectly with abſorbent earths. And decompoſes the ſalts, formed of the volatile alkali; and of earthy or metallic bodies.

Genus 2.

Has nearly the ſame properties with the laſt. But is more acrid, and forms different neutral ſalts, as contained in Order II. Diviſion I.

SUBDIVIS. 2.

Is diſſipated by a moderate heat.

Genus 1.

Differs from the fixt alkalis in the following properties. Unites leſs ſtrongly with other bodies. Is ſo extremely volatile, that with a heat leſs than that of boiling water, it will diſſipate entirely. Is ſo pungent to the ſmell, that it can be endured but for a very ſhort time. Forms cryſtals when it concretes.

ORDER II.

Compoſed of acids and alkalis joined together; or of acids joined to earths; or to metallic bodies.

DIVISION I.

Compoſed of acids and alkalis, and have properties different from both.

DIVISION II.

Compoſed of acids joined to earths.

DIVISION III.

Compoſed of acids joined to metallic bodies.

ORDER III.

Vegetable or animal bodies, depoſited in the earth and joined to ſaline bodies.

CLASS II.

Not malleable; not inflammable; not fuſible in a common degree of furnace fire; or if fuſible, will run into a glaſſy form.

ORDER I.

Conſiſt of parts thoroughly blended, and uniformly mixed.

DIVISION I.

Unite with acids and deſtroy their acidity.

SUBDIVIS. 1.

When burnt in the fire become porous, and gradually diſſolve in the air into quick-lime, but ſpeedily if water is added. Cannot be vitrified in a cloſe fire, without ſome heterogeneous addition.

SUBDIVIS. 2.

Not convertible by fire into quick-lime. Diſſolves readily in the vitriolic acid into a limpid bitter purgative liquor; whereas calcareous earths form with that acid, an inſipid ſelenites; and other earths ſtiptic compounds.

SUBDIVIS. 3.

Diſſolves in every acid. With the vitriolic, forms alum. With the nitrous, a compound reſembling it. And with the vegetable acid, one leſs aſtringent and diſagreeable to the taſte.

SUBDIVIS. 4.

Not convertible into quick-lime. Gives no taſte to water though ſtrongly calcined.

SUBDIVIS. 5.

Not convertible into quick-lime. Perfectly diſſoluble in the mineral acids. Forms with the vitriolic an aſtringent liquor different from that of Subdivis. 2.

DIVISION II.

Does not efferveſce with acids. Does not when burnt fall into a powder in the air or in water, but becomes more porous and full of fiſſures. When free from heterogeneous matter is not fuſible in a common furnace heat. Is eaſily fuſed by the addition of fixt alkali.

DIVISION III.

Vitrifiable with veg. fixt alkali. The moſt tranſparent may be melted without any addition in a blaſt furnace. Different in the facility of fuſion as they are more or leſs tranſparent, or metalline.

DIVISION IV.

Harden in the fire. Have fine conſtituent parts. Some ſoften in water, and when they have imbibed a ſmall quantity, become ductile. Some crack in water when they have imbibed as much as they can, but are not ſoftened. Some imbibe water and do not crack. Some imbibe no water at all.

DIVISION V.

Compoſed of lamina which are thin, ſcaly, flexile, to

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gloſſy, and which in a violent heat become brittle and ſhrivle up. Difficult to be brought to a pure glaſs, without an addition; but eaſily with borax or alkali, eſpecially the ſecond kind.

DIVISION VI.

Strikes no fire with ſteel. Efferveſces not with acids before or after burning, though in the laſt caſe, an inflammable ſubſtance or alkali ſhould be added. Cracks, but does not melt in a ſtrong fire without the addition of other bodies. Mixed with other earths is eaſily brought into fuſion.

DIVISION VII.

Flexile in large pieces. Strikes no fire with ſteel. Is not acted upon by acids. Becomes brittle, but is not fuſible in a very hot furnace. Is eaſily fuſed by an addition of borax.

DIVISION VIII.

Strikes no fire with ſteel, tho harder than fluors. Eaſily melts into a ſoft ſpumous glaſs. Does not efferveſce with phoſphorine ſalt like lime, nor with borax like gypſum. Does not efferveſce with the vitriolic and nitrous acids, but is gradually diſſolved. If the concentrated oil of vitriol is poured on it, when pulverized, an efferveſcence enſues, and the parts of the powder adhere.

DIVISION IX.

Has a ſooty appearance, but when broken a metallic. Communicates a colour to vitrifications and ſolutions by ſalts. Explodes with common nitre. With vitrifying additions and phoſphorine ſalt diſſolves and efferveſces in the fire. Does not efferveſce with aqua fortis, but the aqua fortis extracts the black colour, which with alkali ſubſides in the form of a white powder. The colours which it gives to glaſs, are eaſily diſcharged by arſenic and by fire. All the properties of this, and of ſome of the other earths, are not fully aſcertained.

ORDER II.

Conſiſt of parts not thoroughly blended, nor uniformly mixed.

DIVISION I.

Cloſely united, ſo that the parts are of an uniform appearance, and the cementing matter not eaſily perceived.

DIVISION II.

The component parts are larger, more unequal, and the cementing matter more eaſily diſtinguiſhed.

DIVISION III.

Produced by ſubterraneous fires; or having the ſame properties with bodies which have been produced by them.

DIVISION IV.

Indiſſoluble in acids. Somewhat tenacious when moiſtened with water. Friable when dry. And acquire in the furnace no additional hardneſs.

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CLASS III.

Such as will take fire when a burning body is applied to them, and communicate the flame to the reſt of the ſubſtance, tho the inflaming body is removed.

ORDER I.

Fire combined with ſome other ſubſtance, which ſerves it as a baſis for a kind of ſecondary principle. It cannot be got pure, but can be conveyed from one body to another, ſo as to make part of their compoſition. It communicates neither heat nor light, and changes not the ſolidity of the body, to which it is joined; but, upon the application of fire, renders it much more fuſible.

ORDER II.

Not ſoluble in water, in ardent ſpirits, or in acids. Soluble in oils.

ORDER III.

Unalterable by acids, and by every body except fire. But when on fire, the mineral acids act upon it, if they are combined with other bodies.

ORDER IV.

Burns without the leaſt ſmoke or ſoot. Leaves no ſediment or coal. Perfectly miſcible with water. Diſſolves eſſential oils.

ORDER V.

Conſumes with flame and ſmoke. Leaves a coal after diſtillation. Compoſed of phlogiſton, an acid, an earth combined in a manner unknown, or with an unknown ſubſtance.

DIVISION I.

Found in the earth. Changed by the mineral acids, and by heterogeneous bodies into the genera of this diviſion.

DIVISION II.

Procured from vegetables. Changed by the mineral acids, and heterogeneous bodies into the genera of this diviſion.

SUBDIVIS. 1.

Not miſcible with ardent ſpirits; but eaſily with eſſential oils. Not volatile in the heat of boiling water. Generally inſipid and inodorous.

SUBDIVIS. 2.

Entirely volatile in the heat of boiling water. Have the ſmell and taſte of the vegetables from which they are drawn.

DIVISION III.

Procured from animal bodies.

SUBDIVIS. 1.

Procured from particular parts of animals. Contains an acid which may be ſeparated by fire, or by the rancidity which it acquires with time.

SUBDIVIS. 2.

Procured from almoſt all the parts of an animal body. Contains a little alkali, but not the leaſt acid.

Animal oils when burning are eaſily diſtinguiſhed by the ſmell.

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ORDER VI.

Is luminous in the dark, and will burn without the application of a burning body, or any of the common methods of producing fire.

CLASS IV.

Not miſcible with water. Not inflammable. Fuſible in the fire, and returning to their former texture when cold. Bright when freſh broken, or poliſhed.

DIVISION I.

Malleable. They are diſtinguiſhed into Perfect and Imperfect. The firſt ſuffer no change from the joint effect of the air and fire in the hotteſt furnace. The laſt are unaltered by the ſtrongeſt furnace fire when the air is excluded; but in open veſſels are changed into an earth which has no metallic properties.

Genus 1.

Of a bright yellow colour. Its weight to water is as 19.640 to 1.000 bulk for bulk. Of all bodies the moſt ductile. Has little elaſticity. Is almoſt as ſoft as lead. Is eaſily united with quick-ſilver. Stands the effect of air, water, and the greateſt furnace heat unchanged. Is diſſolved by aqua regia. Precipitated by volatile alkali and nitrous acid. Retains its ductility tho joined to a ſmall proportion of ſilver, platina, copper, or zinc. But is made quite brittle by the fumes of tin.

Genus 2.

Is diſtinguiſhed from gold by the following properties. Its colour is white. When unmixed, its weight to water is as 17.000 to 1.000. When mixed with certain metals, as 22.000 to 1.000. Is harder and leſs coherent than gold. When mixed with other metals or ſemi-metals, is eaſily brought into fuſion: when pure, with the utmoſt difficulty. Does not unite with quick-ſilver, but by means of the muriatic acid. Diſſolved in aqua regia, and precipitated with tin, yields not the mineral purple.

Genus 3.

Malleable only in a great degree of cold. Commonly fluid. White, with a luſtre like poliſhed ſteel. When pure, its weight to water is as 14.000 to 1.000. Tho it eaſily exhales into ſubtil penetrating fumes, and tho it is convertible by furnace fire into the appearance of a calx, yet its parts are not decompoſed. It unites with all the metals and ſemi-metals, except cobalt and nickel. Diſſolves in the nitrous acid, and in the vitriolic by boiling. Is precipitated by an alkali. Is not affected by the muriatic acid, unleſs previouſly diſſolved by other acids. Unites with ſulphur by grinding.

Genus 4.

Of a ſhining white. Its weight to water is as 11.091 to 1.000. Very ductile, tho not ſo much ſo as gold. Unalterable in air, water, or the furnace. May be diſſolved by the nitrous acid, and in the vitriolic, when

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boiling. If precipitated from the acid of nitre by common ſalt or its acid, unites ſo ſtrongly with the muriatic acid, that it melts with it into a maſs like glaſs. Does not unite with nickel by fuſion. Unites eaſily with quick-ſilver. Is acted upon by hepar ſulphuris. Imbibes the fumes of ſulphur. Is exhaled by volatile metals and acids. Melts more eaſily than copper.

Genus 5.

When freſh broken, or cut, of a bluiſh white; but turns blackiſh in the air. Its weight to water is as 11.325 to 1.000. Is ſoft, not very tough, and gives no ſound. Eaſily burns to a calx, which, according to the degree of fire, is white, yellow, or red. This calx melts to a glaſs more eaſily than any other metallic calx; and brings other bodies, and the imperfect metals, into fuſion with it. Diſſolves in the vitriolic acid, in the nitrous, and in the vegetable; in alkaline ſolutions, and in expreſſed oils. Gives a ſweet taſte to all ſolutions. Unites with quick-ſilver. With the muriatic acid, has the ſame effect as ſilver. Does not unite with iron, when joined to it in the fire, without ſome other addition. Melts before it is red hot. Its calx may be reſtored to the metallic ſtate, by the vegetable fixt alkali.

Genus 6.

Of a reddiſh colour. In weight to water as 9.000 to 1.000, when of the fineſt kind. Ductile and ſoft. Its calx when diſſolved by acids become green, and by alkaline ſalts blue. Is eaſily calcined in the fire into a blackiſh ſubſtance, which becomes red by rubbing. When melted with glaſs, firſt acquires a reddiſh brown colour, and afterwards a tranſparent green. Is ſoluble in all the acids, and in all alkaline ſolutions. Can be precipitated in a metallic ſtate. Is not eaſily united with quick-ſilver. Unites ſtrongly with zinc, and tin, and the compoſition is braſs, bell-metal, &c. Is eaſily diſſolved by lead-glaſs, and melts with a leſs heat than iron.

Genus 7.

Of a bluiſh bright colour when poliſhed. In weight to water, when of the fineſt kind, as 8.000 to 1.000. Becomes magnetical. Becomes ductile by hammering, and by being often heated in the fire. Is diſſolved by all ſaline bodies, by water and their effluvia. Is melted with difficulty. Calcines eaſily into a black calx, which when pounded, is of a deep red colour; and which may be diſſolved by the muriatic acid and aqua regia. This calx in a great quantity, gives a blackiſh colour to glaſs; and in a ſmall quantity, a greeniſh. There are three ſorts of iron in common uſe, caſt, forged, ſteel.

Genus 8.

Of a white greyiſh colour. To water in weight is as 7.400 to 1.000, when of the pureſt kind. The moſt fuſible of all metals, and the leaſt ductile. Has a particular ſmell. Is eaſily calcined to white aſhes,

which become a fourth part heavier than the metal; and eaſily mix in glaſs compoſitions. Unites with all metals and ſemi-metals, and renders them brittle, except lead, biſmuth, and zinc. Eaſily unites with quickſilver. Diſſolves in the vitriolic and muriatic acids, and in aqua regia; but is only corroded into a white powder by the nitrous. Is gradually corroded by the vegetable acid, by ſoaps and by pure alkalis. Diſſolves in aqua regia. Heightens the colour of cochineal.

DIVISION II.

Not malleable. Loſe their metallic properties in a certain degree of fire.

Genus 1.

Of a pale yellow colour. Of a laminated texture. Soft under the hammer, and yet very brittle. In weight to water, as 9.700 to 1.000. Diſſolves in aqua fortis, without imparting any colour. To aqua regia gives red. Eaſily unites with quick-ſilver. Mixes with all metallic bodies, except cobalt and zinc; and the compoſition is white and brittle. Is ſpeedily fuſed, and is volatile in the fire. Its glaſs is of a yellowiſh brown colour.

Genus 2.

Of a white colour inclining to red. Of a ſolid texture, and ſhining in its *fractures*. In weight to water as 8.500 to 1.000. Calcines into a green calx, which tinges glaſs with a tranſparent reddiſh brown colour. Eaſily diſſolves in aqua fortis, aqua regia, and in the marine acid; but with more difficulty in the vitriolic; tinging all theſe ſolutions with a deep green. Theſe precipitates are diſſolved by ſalt ammoniac: and the ſolution is blue. Eaſily unites with ſulphur, and forms with it a regulus. Unites with all the metals except quick-ſilver and ſilver; to the laſt it only adheres. Requires near the ſame degree of heat with gold or copper, to bring it into fuſion.

Genus 3.

In colour like lead; but its luſtre is not ſo ſoon ſullied by the air. Seems to be compoſed of flat pyramids. In weight to water as 7.000 to 1.000, when of the pureſt kind. Unites with all the metals except biſmuth, and makes them volatile. Eaſily incorporates with gold or copper; to which laſt it gives a yellow colour. Is diſſolved by all the acids. Unites with quick-ſilver more eaſily than with copper. Melts in the fire before it has acquired a glowing heat. And when it has acquired that, burns with a flame of a changeable colour.

Genus 4.

Of a white colour almoſt like ſilver. Its weight to water is as 7.500 to 1.000. Brittle, and breaks into long ſhining planes. Is volatile in the fire, and carries off part of other metals when mixed with it, except gold and platina. Calcines into a grey calx, which melts into a glaſs of a reddiſh colour. Diſſolves in the marine acid and aqua regia, but is only corroded by

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the nitrous into a white calx. Unites with quick-ſilver by a particular preparation. Has an emetic quality, when its calx, glaſs, or metal is diſſolved in an acid, except the nitrous.

Genus 5.

Nearly of the ſame colour with lead; but in the air changes ſoon to yellow, and afterwards to black. Its fractures have a laminated appearance. Its weight to water is as 8.000 to 1.000. Diſſolves in the nitrous acid. Unites with all metals: and is found mineraliſed. Is very volatile in the fire, and ſmells like garlic. Very difficult to be reduced, unleſs mixed with other metals. Its calx eaſily melts to a glaſs, the weight of which is to water as 5.000 to 1.000; and when mixed with ſulphur, becomes of a yellow, orange, or red colour. Its calx and glaſs are ſoluble in water, and in all liquids, but not with the ſame facility. It is poiſonous, eſpecially in the form of a pure calx, or glaſs.

Genus 6.

Of a greyiſh colour; and of a fine grained texture, like tempered ſteel. Its weight to water is as 6.000 to 1.000. Gives a red ſolution in the vitriolic and nitrous acids, and in aqua regia. Is fixt in the fire, and becomes black by calcination. Gives to glaſs an excellent blue colour inclining to violet. Its calx is diſſolved in the vitriolic, nitrous, and muriatic acids; in aqua regia, and by the volatile alkali. Is red when united with the calx of arſenic in a calcining heat. Does not unite with quick-ſilver, nor incorporate with biſmuth by fuſion, without an addition of ſome other body.

DIVISION III.

Metallic bodies as found in the earth.

SUBDIVIS. 1.

Metals joined to, or united with, other foſſils.

SUBDIVIS. 2.

Semi-metals joined to, or united with, other foſſils.

CLASS V.

Tranſparent. Not inflammable. Fluid or ſolid in different degrees of heat, according as it is more or leſs pure.

DIVISION I.

Inſipid. Volatile. Soluble in air. So ſubtil, as that it will paſs, by preſſure, thro the pores of the fineſt gold. In weight to gold as 1.000 to 19.640. Grows ſolid at thirty-two degrees of heat; and when in that ſtate, is commonly lighter than when fluid. Diſſolves acids,. alkalis, and neutral ſalts, and only a certain quantity of each. When ſaturated with one ſort, will diſſolve a certain quantity of another. And when heated, diſſolves and ſuſtains a greater quantity of ſalts than when cold. Mixes eaſily with ardent ſpirits; but not with ſulphur or oil, unleſs they are deprived of the air which they contain. Has no effect in diſſolving any metallic ſubſtance, except arſenic, unleſs impregnated

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with an acid, an alkali, or neutral ſalt; and then it becomes a menſtruum for ſuch metallic ſubſtances as theſe ſalts can diſſolve. It diſſolves none of the earths, tho they are eaſily ſuſpended in it, except ſome of the calcareous kind when reduced to a quick-lime, or ſaturated with air. But when mixed with an acid, it diſſolves all earthy ſubſtances to which ſuch acids ſerve as a menſtruum. It is only ſimple when no art is uſed; for it is found by a careful analyſis, that the moſt ſimple contain an earthy and oily matter.

Genus 1.

Falls from the atmoſphere in the form of dew, rain, ſleet, ſnow, or hail.

Genus 2.

Is found on the ſurface, or in the bowels of the earth, having no ſenſible taſte, or ſmell. The ſpecies of it are ſpring, pit, river, lake, and ſtagnant water; which are impregnated with different ſubſtances, according to the ſoils or ſtrata thro which they paſs.

DIVISION II.

Found on the ſurface, or in the bowels of the earth, ſo ſtrongly impregnated with ſome mineral ſubſtance, as to affect the taſte or ſmell. Some are very heterogeneous. The characters of the ſubdiviſions and genera are plain from their names.

CLASS VI.

When in a fluid ſtate, highly elaſtic, and ſoluble in water. When in a ſolid ſtate, capable of being detached from many bodies by fire and acids.

DIVISION I.

The ſubtil fluid which encompaſſes the earth, and which is neceſſary to ſuſtain animal, and vegetable life, and flame. When it is mixed with water, duſt, &c. in ſuch proportions as to be ſeen, ſmelled, or taſted, it then forms the ſecond genus.

DIVISION II.

Air produced from other bodies, in which it was in a ſolid or fixed ſtate. It is not fit for ſuſtaining animal, or vegetable life, or flame. The firſt variety is got in caverns. The ſecond by paſſing thro fire. The third by being taken into the lungs of animals. And the laſt four by diſtillation, fermentation, and from alkaline, or abſorbent earths.

CLASS VII.

Particles of matter extremely ſubtil, which give the ſenſations of heat and light; which ſometimes are in a fixed, and ſometimes in a moving ſtate; and the effects of which are different, according to the nature of the bodies in which they are fixed, and by which they are ſurrounded when decompoſed.

Beſides the above arrangement, bodies are divided into Foſſils, Vegetables, and Animals; which are conſidered as three kingdoms in the Material Empire of God.

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Foſſils are bodies, which have not organiſed parts properly ſo called; which are not produced by ſeeds; which are without nerves, or marks of ſenſation; which are commonly found on the external, or internal parts of the earth; and which are compoſed of certain ſecondary particles, according to their kinds.

Vegetables are bodies, which have organiſed parts; which propagate their kinds; which grow to maturity, and then decline; which have no nerves or marks of ſenſation; which are compoſed of the vegetable particles above deſcribed; and which are commonly found on the ſurface of the earth, or in the waters.

Animals are bodies, which have organiſed parts; which propagate their kinds; which paſs thro infancy, maturity, and old age, and die; which have nerves, or marks of ſenſation; which generally, if not always, have a loco-motive power; which are found on the earth, in the air, or in the water; and the particles of which are diſtinguiſhed by certain characters from the other two kingdoms.

SECT. VII.

Of corpuſcular attraction.

PROP. I.

There is an attraction among the particles of the ſame fluid, as among the particles of water, of oil, of quick-ſilver, of melted lead.

PROP. II.

There is an attraction among the particles of the ſame ſolid, as among the particles of lead, of marble, of wood.

PROP. III.

There is an attraction between the particles of ſome ſolid and fluid, and of ſome hard and ſoft bodies; as between water and wood, water and earth, water and ſponge, oil and glaſs, water and glaſs.

PROP. IV.

In capillary tubes, the height to which the ſame fluid will riſe, and be ſuſpended, is reciprocally as the diameters of the tubes; and this is cauſed by the attraction of the ſmall annular ſurface on the inſide of the tubes, to which the upper part of the fluid is contiguous.

PROP. V.

If a veſſel of any ſhape or ſize has its upper part drawn into a capillary tube; if it is filled with water, and inverted in a baſon of water placed in the air, or in vacuo; the whole quantity of the water inverted will be ſuſpended in the veſſel and tube, provided the height of both does not exceed the height from the ſurface of the water in the baſon, to which a capillary of the ſame diameter would raiſe it.

PROP. VI.

Corpuſcular attraction is mutual among the attracting particles. It reaches only to a ſmall diſtance. It

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acts according to the ſurface of cohering bodies, and not according to their quantities of matter. And it ſeems to decreaſe in more than a duplicate ratio of the increaſe of the diſtance; but in what ratio, it is difficult to determine.

SECT. VIII.

Of elective attraction.

PROP. I.

There is an elective attraction among the particles of matter; either abſolute, when a given body is attracted by ſome bodies, and not at all by others; or in degree only, when a given body is attracted by ſeveral others, but more readily and more ſtrongly by one than by another.

PROP. II.

If two bodies attract each other, they will unite, and together form a Mixt or Compound.

PROP. III.

When a given body is attracted by ſeveral bodies, without any difference among them in degree, any number of ſuch may be united with it at the ſame time; but in many caſes, tho a body may be united with ſeveral others, it can be united but with one of them at the ſame time.

PROP. IV.

Two bodies which do not attract each other, may be united together by the interpoſition of a third body which attracts them both.

PROP. V.

Bodies which unite together loſe, by their union, moſt of the properties they had when ſeparate; and the compounds formed, have rather new properties, than thoſe of the bodies which are their principles.

PROP. VI.

If a Mixt conſiſts of two parts, and a third body is applied to it, which attracts one of its parts, and not the other, and at the ſame time attracts that part more ſtrongly than they do each other; a decompoſition will enſue, the parts of the Mixt will be ſeparated from each other, and one of them will form a new Mixt with the body applied. Or if a Mixt conſiſts of two parts, and a third body is applied to it, which, tho it may be united with either of the parts, is however more ſtrongly attracted by one of them than by the other, while at the ſame time, it attracts that part more ſtrongly than the parts do each other; in this caſe too, if the condition in Prop. III. takes place, a decompoſition of the Mixt will enſue, and a new compound will be formed of one part of the Mixt, and of the body applied.

PROP. VII.

A body, which of itſelf cannot decompoſe a Mixt conſiſting of two ſubſtances, becauſe of the ſtronger attraction between them, may become capable of ſepa-

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rating them, if when it is applied to them, it is itſelf combined with another body, having a force of attraction towards one part of the Mixt ſufficient to compenſate its own want thereof towards the other.

In ſuch caſes, a double decompoſition, and a double combination enſues.

Of the theory of elective attraction.

SECT. IX.

Of the coheſion of bodies.

PROP. I.

The coheſion of fluids, rain-water being the ſtandard, and 56 the degree of heat, is, at a medium, as follows.

Alcohol.	16	Cows milk.	38
Oil of Olives.	20	Urine.	43
Oil of Saſſafras.	21	Rain-Water.	50
Oil of Vitriol.	34	Sea-Water.	56
Ale.	36	Quick-Silver.	64

PROP. II.

The abſolute coheſion of flexible cylindric ſolids of one tenth of an inch in diameter is, at a medium, as follows.

	lb.		lb.
Raw Lint.	37	Raw Hemp.	46
Horſe hair.	45	Raw Silk.	53½

PROP. III.

The abſolute coheſion of cylindric pieces of wood of one tenth of an inch in diameter is, at a medium, as follows.

	lb.		lb.
Fir.	23	Oak.	48
Elm.	35	Beech.	50
Alder.	40	Aſh.	50 &c.

PROP. IV.

The abſolute coheſion of cylindric pieces of metal of one tenth of an inch in diameter is, at a medium, as follows.

	lb.		lb.
Zinc mixed.	18	Braſs.	360
Lead.	29¼	Silver.	370
Tin.	40½	Iron.	450
Copper.	299	Gold.	500

Of the uſefulneſs of ſuch experiments; and of the cauſe of the variations which take place in making them.

SECT. X.

Of corpuſcular repulſion.

PROP. I.

There is a repulſion between the particles of certain different fluids; as between water and oil, water and metals in fuſion.

PROP. II.

There is a repulſion between the particles of certain different ſolids; as between the ſurfaces of poliſhed pieces of ſteel; or between the ſurfaces of convex glaſſes.

PROP. III.

There is a repulſion between the particles of certain ſolids and fluids; as between camels hair and water; poliſhed ſteel and water.

PROP. IV.

There is a repulſion among the particles of the ſame fluid; as among the particles of common air; or among the particles of water; or of mercury, when in a certain temperature.

PROP. V.

There is a repulſion among the particles of the ſame ſolid; as among the particles of metal when heated; and among the internal particles of glaſs tears, or Prince Rupert's drops.

PROP. VI.

Corpuſcular repulſions ſeem to take place, as ſoon as the particles are without the ſphere of their mutual attraction: to reach only to a ſmall diſtance: and to decreaſe in more than a duplicate ratio of their diſtance from the limits of that attraction.

Of the difficulty of aſcertaining the laws of corpuſcular attraction and repulſion.

SECT. XI.

Of fire and its effects.

PROP. I.

The action of fire, when in a certain quantity, excites the ſenſation of heat; and the diminution of that action, the ſenſation of cold. By encreaſing or diminiſhing the quantity, theſe ſenſations may be encreaſed or diminiſhed in various degrees.

PROP. II.

In eſtimating heat and cold by the feeling, the judgment will be according to the temperature of the parts of the human body which are applied; but if the ſame part is applied, or different parts when of the ſame temperature, the judgment will be according to the denſities of the bodies to which they are applied, all circumſtances being equal.

PROP. III.

When fire moves in ſtraight lines in a certain quantity, and is modified in a particular manner, it gives the ſenſation of light. There may be heat and no ſenſible light, and light and no ſenſible heat.

Of the attraction and repulſion of fire.

PROP. IV.

Bodies, expoſed to heating and cooling media, gain or loſe, in equal times, quantities of fire proportional to the temperature, in the hotter body.

Cor. 1. When the exceſs is conſtant, equal quantities are gained or loſt in equal times.

Cor. 2. There is, after a certain time, the ſame heat; that is, power of exciting heat; in an air pump vacuum, and in the adjoining air, water, wood, and metals.

PROP. V.

The more remote a cold body is from a hot one, the leſs is it heated; and in the duplicate ratio of the diſtance.

PROP. VI.

Bodies of the ſame kind of matter receive fire, or are heated, in proportion to their ſurfaces, all circumſtances being equal; and they retain it, or cool, in proportion to their quantities of matter.

PROP. VII.

Metalline bodies, by being reduced to a calx by fire, are increaſed in their weight.

In an open veſſel, one hundred pounds of lead, when calcined in a furnace, is encreaſed to an hundred and ten pounds. One pound of zinc acquires two drachms and an half. Biſmuth is encreaſed one fortieth and eighth part. And tin one twelfth.

In a cloſe veſſel, an ounce of tin calcined in the furnace acquires four grains and an half. An ounce of copper, forty-nine grains. And an ounce of antimony, two drachms.

In the focus of a burning glaſs, one pound of regulus of antimony, when calcined, acquires a tenth part more; and this is the caſe with many other metallic bodies.

PROP. VIII.

If a metal is diſſolved in an acid, the mixture is heavier than the ſum of the weights of the metal and acid. Or if a metal is diſſolved in an acid, and precipitated by a cauſtic fixed alkali, the calx is heavier than the metal.

PROP. IX.

Fire is repelled by certain bodies; by ſuch, for inſtance, as are very white, and by poliſhed metals; and it ſometimes has fits of attraction and repulſion among the particles of the ſame body.

Of the elective attraction of fire.

PROP. X.

Many bodies, tho of the ſame temperature, of the ſame bulk, of the ſame ſhape, and equally expoſed to the ſame degree of fire, do not attract equal quantities of it in the ſame time; as for inſtance, the different kinds of wood; and metals compared to wood, and to one another. The celerity with which the following fluids are heated, is according to this order. Air. Mercury. Petroleum. Oil of turpentine. Alcohol. Spirit of wine. Vinegar. Oil of vitriol. Water. Animal juice. White wine. Milk. Salt water. Aqua fortis. Lintſeed oil. Olive oil.

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PROP. XI.

All circumſtances being equal, this is the order in which the following bodies cool. Air. Mercury. Alcohol. Oil of turpentine. Water. Petroleum. Oil of vitriol.

PROP. XII.

Bodies of different colours receive different degrees of heat, in the ſame time, and in this order. Black, Purple, Blue, Green, Yellow, Red, White; the firſt being the moſt heated.

Cor. Hence the effect of colour in utenſils, cloaths, and garden walls.

Of the great care and delicacy with which experiments on fire muſt be made; and without which, and making an allowance for the unavoidable loſs and gain of heat by the ſurrounding bodies, none of the nicer experiments will ſucceed.

PROP. XIII.

If a porcelane cup be filled with water, and fixed in the mouth of a metallic veſſel, which is likewiſe filled with water, and made to boil upon the fire; the heat of the water in the veſſel will be greater than that in the cup. If, inſtead of the porcelane cup, different metallic ones are uſed, the heat of the water in the cups will ſtill be leſs than that in the veſſel, tho not in the ſame proportion.

PROP. XIV.

The ſun's rays, collected in a great quantity, will inflame combuſtible matter placed in the midſt of water, while the water acquires but a ſmall degree of heat.

PROP. XV.

If maſſes of metals, earths, woods, or fluids in veſſels, are incloſed in wrappers of wool, cloath, ſkins, hair, or feathers, their heat will be preſerved much longer than if they were incloſed by air, or water, to the ſame extent with theſe wrappers.

Cor. Hence the effect of covering up ſnow, ice, plants; and of cloathing of different kinds to animal bodies.

PROP. XVI.

Hot water cools ſooner in vacuo than in the air; but hot iron more ſlowly. Chalk is ſlow in heating, and loſes its heat very ſoon.

PROP. XVII.

A body which attracts fire ſlowly, or in a ſmall quantity, may be made to attract it quickly, and in a large quantity, by its union with a third body.

Of the expanſion of fluids.

PROP. XVIII.

All fluids are dilated by fire; but the dilatation is not according to their denſities or coheſions. Perhaps it is in a ratio compounded of both, and of their elective attractions. The following fluids dilate, and contract, with different degrees of celerity, according to the

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order in which they ſtand. Air. Mercury. Alcohol. Oil of turpentine. Water. Petroleum. Oil of vitriol.

PROP. XIX.

As ſoon as a fluid is made to boil, it is, if in the open air, in the ſtate of its greateſt expanſion.

PROP. XX.

Bodies, when in a fluid ſtate, are in general leſs denſe than when in a ſolid. But ſolid water is not commonly ſo, on account of the air with which it is mixed. The force with which it expands is ſo prodigious, as to overcome the coheſion of the ſtrongeſt iron veſſels; and to raiſe up the greateſt maſs of Building.

Cor. Hence the effects of water lodged in trees, walls, or rocks, during a great froſt, even in temperate climates.

PROP. XXI.

From the degree of heat at which water freezes, to the degree at which it boils, the following bodies are increaſed in bulk in this proportion. Lintſeed oil, ſeventy-two parts of a thouſand; ſpirit of wine, eighty-ſeven; and mercury, fourteen.

PROP. XXII.

Water encreaſes in bulk one eightieth and fifth part, from the degree of heat at which it freezes, to the degree of heat at which it boils. Alcohol encreaſes one ninth part from the degree of heat at which water freezes, to the degree of heat at which alcohol boils.

Mercury encreaſes four parts of fifty-one from the degree of heat at which water freezes, to the degree of heat at which mercury boils. And mercury is leſſened in bulk one tenth part from its boiling to its freezing point.

Of the expanſion of ſolids.

PROP. XXIII.

Solid bodies are dilated by heat, and not in the direct ratio of their denſities, or the inverſe of their coheſions.

Cor. Hence, and from Prop. IV. if a fluid is put into a glaſs tube, the fluid will ſink when the tube is firſt immerſed in hot water.

A Table of the Expanſion of Metals.

Shewing, how much a foot in length of each, grows longer by an increaſe of heat, correſponding to 180 degrees of heat in Fahrenheit's thermometer, expreſſed in parts, the unit of which is equal to the 10.000th part of an inch.

Barometer Tube.	100	Braſs Wire.	232
Hard Steel.	147	Speculum Metal.	232
Iron.	151	Fine Pewter.	274
Biſmuth.	167	Zinc a little hammered.	323
Copper hammered.	204	Lead.	344
Caſt Braſs.	225	Zinc, or Spelter.	353

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Of the variations, in making ſuch experiments, owing to the different degrees of purity, or to the hammering of the metals.

PROP. XXIV.

Foſſil bodies, upon the firſt application of fire, dilate with alternate Fitts of ſlowneſs and quickneſs, but afterwards, more and more ſlowly, till they arrive at the higheſt degree of expanſion.

PROP. XXV.

Vegetable bodies are contracted by fire, in various degrees, according to the water, or reſins, which they contain. Some contract very little if cut longitudinally; but all are apt to warp, unleſs in large maſſes, or ſecured from moiſture.

PROP. XXVI.

Some animal ſubſtances are contracted by fire; but others, ſuch as ivory, whalebone, hartſhorn, oxhorn, cat-gut, ſilk-ſtrings, dilate or contract, and unequally, according to a variety of circumſtances.

PROP. XXVII.

Common iron, but not fine ſteel, when fully liquified, is more denſe, than when ſolid; as ſoon however as it is ſolid, it decreaſes in denſity, till it is cold.

Of Thermometers.

Of the conſtruction, advantages, and diſadvantages of the Air thermometer; of the thermometer made by the Florentine Academy; by the Royal Society; by the

Academy of Sciences; by Newton; by Fahrenheit; by Reaumeur; by De L'Iſle; and by others.

PROP. XXVIII.

In the ſcale of Fahrenheit's thermometer, the freezing of water is marked 32. The boiling of water in the common ſtate of the air, 212. Human heat, 96. The boiling of mercury, 600. The cold produced by a common mixture of ſnow and ſal ammoniac, 0. The greateſt artificial cold which Fahrenheit was able to produce, 40 below 0. The cold at which, of late years, by an artificial mixture, the freezing of mercury began, was about 350 below 0; and the mean term of congelation, 568.

When heat is mentioned in this book by a number; that number, unleſs otherwiſe expreſſed, refers to Fahrenheit's ſcale.

PROP. XXIX.

In Newton's thermometer, 0 correſponds to 32 in Fahrenheit's, and 34 to 212; which degrees are ſubdivided into minuter parts. In Reaumeur's thermometer, 0 correſponds to 32 in Fahrenheit's; 80 to 212; 250 above 0 to 600; and 187 below 0, to 390. In De L'Iſle's thermometer, 0 correſponds to 212 above 0; about 152 below 0, to 32 above 0; 328 above 0, to 600 above 0; 469 below 0, to about 350 below 0; and 500 below 0, to 390 below 0.

Of Pyrometers.

Of the conſtruction, advantages, and diſadvantages

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of the ſimple pyrometer; of the lever pyrometer; of the pyrometer made by M. Graham, Muſſchenbroek, Ellicot, Smeaton, and others.

Of the evaporation of fluids and ſolids.

PROP. XXX.

The particles of all bodies, when in open veſſels, are diſſipated by the application of fire in a certain quantity. A ſmall degree of heat produces this in ſome, while the greateſt is neceſſary for producing it in others.

PROP. XXXI.

If a veſſel of water is placed where the air has but little motion, and its heat is 60, it will evaporate about eight inches of its depth in one year; and if it is kept at the ſame degree of heat with that of the air in a hot day in ſummer, it will evaporate about the ſixtieth part of an inch of its depth in two hours. If it is expoſed to a ſtrong wind, it will evaporate much more.

Of Fuſion.

A table of the degrees of heat by which fuſion is produced in certain bodies.

		Deg.		Deg.
Tin.	at	408	Iron.	869
Lead.		504	Olive Oil.	36
Biſmuth.		460	Honey.	104
Regulus Martis.		805	Pitch.	186

	Deg.		Deg.
Reſins.	240	Fat of Horſes.	96
Sulphur.	244	Hogs.	100
Bitumen.	300	Veal.	100
Common Butter.	88	Bullocks.	104
Fat of Swans.	60	Sheep.	124
Geeſe.	68	Stags.	116
Ducks.	80	Hares.	120
Fowls.	68	Bees wax.	140
Vipers.	96	Sperma ceti.	180

Of the variations which take place in making ſuch experiments.

PROP. XXXII.

Some bodies cannot be reduced to fuſion by furnace fire, or with difficulty; but if another body is added to them, they may be eaſily fuſed.

PROP. XXXIII.

A compoſition of lead, zinc, and biſmuth, in equal parts, may be kept in fuſion, when they have a degree of heat which will not ſinge paper. A compoſition of one part of lead, four parts of tin, and five of biſmuth, will melt at 246 degrees. And a compound metal of lead, tin, biſmuth, and mercury; their proportions being as two, three, five, and one eighth part; will melt with a heat leſs than that of boiling water.

PROP. XXXIV.

After bodies are brought into fuſion, they are cap-

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able of having their heat encreaſed in different degrees, till they are fully ſaturated with the fire, and then they have a white heat, which is not diſtinctly ſeen in twilight till the degree of heat is 884.

PROP. XXXV.

By collecting the rays of the ſun, heat has been encreaſed ſo as to produce the following effects. Clay, ſand, marble, jaſper, porphyry, fireſtone, crucibles, flints, animal bones, and pumice ſtone were melted into glaſs. Gems became friable. Gold was vitrified, or diſſipated into ſmoke. Aſbeſtus was turned into a yellow ſlag. Copper ore was turned into glaſs in eight ſeconds. A piece of Roman patera began to melt in three. And in fifty, a piece of the Alexandrian pillar was fully vitrified.

Of Boiling.

PROP. XXXVI.

All fluids, excepting air, that are homogeneous, and that exhale without any ſeparation of their parts, may be made to boil by fire, and then they are as hot as they can be in the open air; but by confining the ſteam, the heat may be encreaſed prodigiouſly; and the water will receive greater or leſs degrees of heat before it boils, according to the weight of the ſuperincumbent atmoſphere.

PROP. XXXVII.

While the air is of a mean weight, aether will boil at about 100 degrees of heat; alcohol at 176; water at 212; ſpirit of nitre at 242; lixivium of tartar at 240; oil of vitriol at 546; lintſeed oil and quick-ſilver at about 600.

Of the burning of Bodies.

Of Smoke. Of Flame. Of Calx.

Of the methods of producing Heat.

PROP. XXXVIII.

Heat is produced in various degrees by mixing,

The vitriolic acid with water, in a certain temperature, with Rheniſh wine, alcohol, vinegar, calcareous earth, lapis namurcenſis, pit-coal, lapis calaminaris, iron, marcaſite, ſalt ammoniac, ſal gem, ſugar, oil of aniſeed, and a variety of oils.

The ſpirit of nitre, with lead, ceruſs, ſac. ſaturni, minium, litharge, tin, iron, copper, braſs, ſilver, biſmuth, marcaſite, antimony, haematites, lapis calaminaris, tutty, lixivium of aſhes, ſweet milk, ſpirit of ſal ammon. urine, vinegar, ſome calcareous earths, orange juice, white wine, oil of ſaſſafras.

The ſpiritus fumans nitri, with many oils, produces heat, but does not take fire. With the following bodies it effervеſces, and with an exploſion ſets them on fire; with oil of caraways, ſaſſafras, guiacum, box, camphor, pepper, cinnamon; with cornu cervi, cranium humanum, ungulae, ſanguis humanus.

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Aqua fortis, with alcohol, ſpirit of ſal ammon. alum, borax, oil of tartar, calcareous and bone-earth, lapis namurcenſis, pit-coal, haematites, urine, ſilver, lead, ceruſs, gold-litharge, tin, copper, braſs, tutty, iron, biſmuth, marcaſite, antimony.

The ſpirit of ſea-ſalt, with urine, iron, copper, tin, biſmuth, marcaſite, calcareous and bone-earth, ſac. ſaturni, common ſalt.

The vegetable acid, with ſalt of tartar, oil of tartar, ſpirit of ſea-ſalt, lapis namurcenſis, and calcareous earths.

Alcohol, with vinegar, urine, ſalt of tartar, ſpirit of ſea-ſalt, ſpirit of nitre, ſal ammoniac and water, ſome calcareous earths, blood, empyreumatic oil.

Water, with ſugar, ſalt of tartar, white wine, ſpirit of wine, aqua fortis, ſpirit of ſea-ſalt, oil of vitriol.

In making ſome of the above experiments, ſo ſmall a degree of heat is produced, that it not only requires great attention to obſerve it, but the ſucceſs of the experiments depends on the time employed, and the purity, or proportions of the bodies mixed. By varying the circumſtances, the ſame mixture will produce heat or cold. By an efferveſcence, ſometimes heat is produced, ſometimes cold, ſometimes neither. Sometimes heat is produced without any inteſtine motion at all.

If ſpirit of nitre, or oil of vitriol, which is at 33 degrees above 0, be added to water which is at the ſame, it will raiſe the thermometer to 41.

If water, acid of vitriol, and iron are mixed together, they will produce an efferveſcence and heat; and the vapour ariſing from them may be eaſily inflamed.

If large and equal quantities of ſteel filings and powder of ſulphur are made into a paſte with water, they will, after ſome time, break out into a flame, tho covered up cloſely with earth.

If two parts of aqua fortis, and one of oil of vitriol are mixed together, and poured to an equal bulk of oil of turpentine, the mixture will kindle into a flame.

PROP. XXXIX.

Heat is produced by fermentation; and by putrefaction.

PROP. XL.

If the wind blows upon a thermometer which is wetted with lintſeed oil, or petroleum, it will riſe; but if it had been perfectly dry, it would have continued at the temperature of the air.

PROP. XLI.

Heat is produced, and ſometimes flame, by attrition; as by the violent friction of the parts of large machines, when ſome fluid is not interpoſed; by the rubbing of ſticks, ropes, &c.

PROP. XLII.

Heat is produced by percuſſion, as by hammering a ſmall piece of iron, if it makes part of a large maſs.

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PROP. XLIII.

Heat is produced by colliſion; as by the ſtriking of flint againſt ſteel.

PROP. XLIV.

While cloth is fulling, it is heated, tho moiſtened by a ſtream of cold water. Some cloths when laid in heaps, have been heated ſo much as to take fire.

PROP. XLV.

Heat is produced by expoſing phoſphorus to the air.

PROP. XLVI.

By an aſſemblage of the ſun's rays, a heat may be produced which will diſſipate the moſt firm, and the leaſt inflammable bodies. And yet the power which the rays have to produce ſuch effects encreaſes in ſo high a ratio, that their heat at a ſmall diſtance from the focus does not equal that of boiling water.

Cor. Hence one cauſe of the power of the Blow-Pipe by contracting the flame.

Of the methods of producing Cold.

PROP. XLVII.

Cold is produced in various degrees by mixing,

The vitriolic acid greatly diluted, with nitre in a certain proportion; and with the volatile ſalt of urine.

Aqua fortis, with ſal ammoniac.

Spirit of ſea-ſalt, with antimony.

The vegetable acid, with ſal volatile urinae, with all volatile alkaline ſalts, and with lapis namurcenſis in vacuo.

Alcohol with ſal ammoniac, with almoſt all eſſential oils, oil of turpentine, camphor, and balſam of copaiva.

Water, with the vitriolic acid when of a certain temperature, with nitre, borax, ſea-ſalt, ſal ammoniac, blue vitriol, verdegreaſe, rock-alum, tartar, and volatile ſalt of urine.

PROP. XLVIII.

If a veſſel containing water be ſet in ſnow or pounded ice, with which is mingled common ſalt, ſalt ammon &c. as the ſnow or ice melts away, the water will freeze in the veſſel. Or if the whole be ſet upon the fire, as the ſalt and ſnow grow liquid by the heat, the ſame effect will follow.

PROP. XLIX.

If ſpirit of nitre, or oil of vitriol, be mixed with ſnow or powdered ice, it will produce a great degree of cold, even to 40 below freezing. If the ice ſo produced be mixed with the ſtrongeſt ſpirit of nitre, which has been cooled artificially, and if the ſame operation be often repeated, when the heat of the air is not greater than 2 above 0, the cold of the mixture will be encreaſed to ſuch a degree, as to freeze the mercury in the thermometer. The greater the cold of the air, the better does the experiment ſucceed. When it was very great, the artificial cold produced in this manner was between 1500 and 1600 below 0.

PROP. L.

Intenſe cold may be produced by the evaporation of a great number of volatile fluids. ſuch as, aether, volatile tincture of ſulphur, alcohol, brandy, wine, vinegar, water, oil of turpentine, oil of mint, and oil of pimento.

Cor. Liquors, and animal bodies may be cooled in the hotteſt weather; and ice may be produced.

Of the effects of the Air upon Fire.

PROP. LI.

Air is neceſſary to the ſupport of flame, but not in the ſame degree to all burning bodies.

A Lamp

With a two-threaded cotton-wick $\frac{6}{100}$ of an inch in thickneſs, when placed in a receiver the capacity of which is $196\frac{6}{7}$ cubic inches, burns with

	Sec.		Sec.
Spirit of Wine.	20	Oil of Turpentine.	22
Lintſeed Oil.	110	Saſſafras.	55
Melted Ducks Fat.	70	Roſemary.	82
Melted Gooſe Fat.	90	Juniper.	85
Rapeſeed Oil.	170	Whale Oil.	110
Olive Oil.	128	Petroleum.	30

A Candle

Half an inch in diameter, and with a ſmall wick, when made of

	Sec.		Sec.
Pitch, burns	32	Veal Tallow.	50
Sperma Ceti.	80	White Wax.	63
Sheep Tallow.	48	Aſphaltum.	55
Ox Tallow.	45	Sulphur.	65

Of the variations which take place in making theſe experiments.

PROP. LII.

When air is forced into a receiver, lamps and candles are longer of being extinguiſhed, but they cannot be kept burning by any addition of air that can be made.

PROP. LIII.

In an exhauſted receiver, ſpirit of nitre added to oil of caraway ſeeds, flames and explodes with great violence. Charcoal and phoſphorus urinae take fire. A mixture of oil of vitriol, oil of tartar, oil of cloves, and phoſphorus urinae produces fire in the open air, which may be extinguiſhed by a little water. But if this mixture is put into an exhauſted receiver, it will not only ſhine, but boil up into a flame. The particles produced by flints ſtriking againſt ſteel, are ſhriveled up; or they are globules of fuſed metal, ſome of which are vitrified. In an exhauſted receiver, no light is produced, but the globules have the ſame appearance.

PROP. LIV.

Rotten wood, and rotten fiſh, ceaſe to be phoſphori in vacuo; but upon the admiſſion of air, if after a ſhort time, they recover their phoſphorine property.

PROP. LV.

Phoſphorus urinae ſhines for a long time brighter in vacuo than in the air. When a diamond has been expoſed to the ſun's rays, and is brought into a dark room, it ſhines as well in the exhauſted receiver, as in the air.

Of Latent, or Imbibed, Fire.

PROP. LVI.

If a piece of ice is in a medium, which contains a greater quantity of fire than is neceſſary to melt it, the temperature of the ice will continue riſing (Prop. IV.) till the ice begins to ſoften, and then its temperature will be ſtationary for about 150 times longer than the time which it took to riſe from 30 to 31 degrees. At the end of this time, the ice will be perfectly fluid, and its temperature will become progreſſive, according to Prop. IV.

If a pound of water, the temperature of which is about 32, is poured to an equal quantity of water which is at 212, the temperature of the mixture will be 122. But if a pound of beaten ice is mixed with an equal quantity of water at 212, the temperature of the mixture will be 47.

PROP. LVII.

If water, at a temperature ſeveral degrees higher than 32, is expoſed to a medium conſiderably lower; when the water arrives at that temperature in which it can no longer remain fluid, it is ſtationary for near 150 times the time ſpent in paſſing from 34 to 33 degrees. After all the water is perfectly frozen, it begins immediately to ſink in its temperature, according to Prop. IV.

If a ſolution of Glauber's ſalt is made at 180, and kept at that temperature; if it is let cool, without being expoſed to agitation, it will cool without being cryſtallized. But if it is quickly ſhaken, it will inſtantly cryſtallize, the thermometer at the ſame time riſing ſeveral degrees.

PROP. LVIII.

If a thermometer is placed in water, which is at perfect reſt, and during a moderate froſt, the water will ſometimes continue fluid, after the thermometer has ſunk below the freezing point; but upon giving it a ſhake, it will freeze in an inſtant.

PROP. LIX.

If one thermometer is put into a freezing mixture, and another over it; the firſt will ſink, and the ſecond will riſe, as the freezing goes on. By the condenſation of ſteam, heat is generated.

Of Animal Heat.

PROP. LX.

There is no vital heat in the moſt inflammable foſſils, or in the moſt flouriſhing vegetables; but the heat in living animal bodies is different from the ſurrounding medium, according to their kinds, and according to the ſeaſons.

Moſt inſects have but a ſmall degree of heat above the air they live in, and they are preſerved in the coldeſt ſeaſon with a little ſhelter. The heat of a ſwarm of bees is 96 or 97.

The heat of fiſhes is in general nearly the ſame with the medium in which they live. The cetacea have a heat equal to that of the human body.

Birds are the warmeſt of all the animals. Their heat is from 100 to 108 degrees.

The heat of the common quadrupeds is from 100 to 103. The colour of ſome birds and quadrupeds is changed by cold.

The heat of a healthy, cloathed, carnivorous man, at reſt, is 96.

Of froſt-biting. Of the deſtruction of animal life by cold; and by heat.

Of the Heat of the Earth.

PROP. LXI.

There is a permanent heat in the bowels of the earth independent of the ſhining of the ſun, and very different from that on the ſurface of the earth and waters.

PROP. LXII.

The heat in different places on the ſurface of the earth, depends upon other circumſtances much more than the obliquity of the ſun's rays, or the diſtance from the poles. Theſe circumſtances are, the height above the ſea, the length of the day, the ſerenity of the ſky, ſubterraneous fires, the ſoil, the denſity of the air, the winds, the neighbouring rivers, lakes, ſeas, woods, hills, and maſſes of ſnow or ice.

PROP. LXIII.

Small bodies ſoon arrive at the ſame heat; but lakes, ſeas, and mountains, require a long time to come to the temperature of the circumambient medium. There are ſuch frequent changes in the atmoſphere, that the temperature of the bodies on the ſurface of the earth is never almoſt the ſame; and they are in a conſtant ſtate of dilatation and contraction.

Cor. Hence the heat of the earth and ocean is different at different depths. The water below ice is often conſiderably warmer than the ice. The cold in the upper ſurface of ſnow is at 0, while the cold in the under ſurface is a little below 32. Hence ſome lakes do not freeze till the winter is far advanced, and others do not freeze at all. Lava retains its heat a long time, and unequally. Hence, and from the foregoing propoſitions, the cold is greateſt on the tops of hills; and,

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other circumſtances being equal, the mildeſt ſeaſons are in iſlands, and on ſea-coaſts. Hence the effect of winds in cooling animal bodies; which effects are varied according to the ſeas or countries from which the winds come, and according as they are moiſt or dry. And hence in high houſes, the uppermoſt ſtory is the hotteſt in the morning, the lowermoſt is the cooleſt, and this temperature is reverſed at night.

PROP. LXIV.

The ſurface of the earth in ſome countries has been heated by the ſun's rays from 150 to 212 degrees above 0.

The air at Peterſburgh, A. D. 1734, was 98 above 0. At Leyden, A. D. 1750, 92. At Utrecht, A. D. 1733, 94. At London, A. D. 1746, 85. At Senegal, 110. At Podor, 134.

The ground, if not very moiſt, is ſeldom frozen deeper than a few feet, even in northern countries.

The air in Britain, A. D. 1768, was 2 degrees below 0. At Peterſburgh, A. D. 1739, 30; and A. D. 1759, about 42. At Selingenſkoy, it has often been 55. At Kirengens, A. D. 1738, it was at 113. And at Jeniſſa, A. D. 1735, it was at more than 120 below 0.

Of the Heat of the Sun and Planets.

PROP. LXV.

As heat depends on other circumſtances much more than upon the denſity of the ſun's rays; and as we are ignorant of the nature of the Matter of which the ſun and planets conſiſt, we can form no judgment of their heat; nor is the heat of the planets to be eſtimated by their diſtance from the ſun.

Of the different theories of fire; and a theory of it founded upon the above, and other experiments.

SECT. XII.

Theories of corpuſcular phaenomena.

Of combining and decompoſing bodies by ſolution, fuſion, evaporation, precipitation, fermentation, putrefaction.

Of painting, dyeing, cementing, ſoldering, etching; and the principles of various arts.

Of the capillary ſiphon.

Of filters of different kinds.

PROP. I.

Several liquors may be mixed together, and if filters are applied to them, the liquors may be drawn off ſeparately.

Of the riſe of ſap in vegetables; and the ſecretions in animal bodies.

Of hot ſprings or fountains.

Of inflammable exhalations. Of ſuffocating vapours, corruſcations, and exploſions in mines and caverns.

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Of the effects of mixing bodies which produce elaſtic fluids.

PROP. II.

If fire is applied to ſalt-petre and ſulphur when mixed together, they will explode and flame.

Of gun-powder, fire works and rockets.

Of pulvis fulminans, aurum fulminans, and the effects which they produce.

Of ſteam. Of the aeolopile.

PROP. III.

One ounce Troy weight of water makes 9250 cubic inches of ſteam, of equal force with the ſame number of inches of air, and the weight of ſuch ſteam is one fifth part of the weight of common air.

PROP. IV.

The ſteam of one cubic inch of water is ſufficient to exclude the air out of a veſſel of 4000 inches in capacity.

Of Papin's digeſter, and the effects produced by it.

Of vulcanos and earthquakes.

Of Configurations.

PROP. V.

Configurations are as various as can be imagined; but in the ſame circumſtances, they are always the ſame.

Of Cryſtals.

PROP. VI.

Sea-ſalt, when cryſtallized, produces cubes, many of which are formed into pyramids with a hollow quadrangular baſe. Nitre, parallelepipeds of ſix angles. Salt of laurel, partly hexangular parallelepipeds, and partly truncated pyramids. Salt of liquoriſh, double hexangular pyramids. Salt of white hellebore, rhombuſes. Vitriol, rhomboidals. Alum, octogonals. And other ſalts, other ſolids; but the cryſtals of the ſame ſalt are invariably the ſame.

Of the appearances produced by the bodies which are floating or ſolved in the air, when concreted by froſt.

Of the figures of the flakes of ſnow, and hail. Of ice, and the freezing of water.

Of the configurations and cryſtals which are found in the earth; and of the cryſtalline appearances which large ſtones often have.

The theory of the above phaenomena explained by the principles eſtabliſhed in the foregoing ſections, and by a variety of other experiments.

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ELECTRICITY.

SECT. I.

Of electric and non-electric Bodies.

PROP. I.

EVERY piece of matter is either an Electric or Non-electric, or more properly a Non-conductor or Conductor.

To the firſt claſs belong amber, glaſs, ſilk, ſealing wax, ſulphur, roſin, ſugar, hair, feathers, baked wood, pure-air, &c.

To the ſecond claſs belong metals and ſemi-metals, water, flame, animal bodies, common earth, &c.

PROP. II.

Amber, glaſs, wax, ſulphur, roſin, ſugar, air, baked wood, when made very hot are conductors. Frozen water is a non-conductor.

PROP. III.

The ſurface of new glaſs tubes often conducts electric matter; but after ſome time it loſes that property. If the tubes are made red hot, they recover it again, and loſe it as before.

PROP. IV.

Electric matter is always conducted thro the ſubſtance of metals, but it ſometimes paſſes over the ſurface of water, of animal, and of ſome other bodies.

PROP. V.

Some bodies have Fits of conducting and non-conducting. Thus free-ſtone, or dried clay, if hot enough to ſinge paper, conducts as perfectly as when cold; but on cooling a little, it begins not to conduct, and this property encreaſes gradually for ſome minutes, till it arrives at a perfect non-conducting ſtate, in which it continues near a quarter of an hour. At the end of this time, it begins again to conduct, and gradually encreaſes as it grows cooler, till it returns to its firſt conducting ſtate.

PROP. VI.

Some conductors, ſuch as ſtone or brick, become non-conductors, when reduced to a fine dry powder.

PROP. VII.

The minuteſt filings of metals are conductors; but metallic calces, and the ruſt of metals, are non-conductors.

PROP. VIII.

Charcoal is a good conductor; ſome animal and vegetable ſolids become non-conductors, when reduced to aſhes.

SECT. II.

Of electric Matter.

PROP. I.

An excited non-conductor, or electriſed conductor

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when inſulated, is ſurrounded by a maſs of very ſubtil matter, which is the cauſe of the attraction and repulſion of light bodies; and the form of this matter is that of the body it ſurrounds.

PROP. II.

The particles of electric matter eaſily pervade the denſeſt conducting bodies.

PROP. III.

Tho electric matter be extremely ſubtil, yet it may be ſeen, if it runs off in a ſtream, or if it leaps from body to body, but not otherwiſe; and it may be heard, ſmelled, felt, and taſted, if accumulated in large quantities.

Of the light excited by rubbing glaſs with quickſilver. Of the military lantern.

PROP. IV.

Electric matter is not created by friction, but collected; being diffuſed thro all bodies.

PROP. V.

Fire and electric matter are either different elements, or different modifications of the ſame element. If they are different elements, they may and do ſubſiſt together in the ſame body. If they are different modifications of the ſame element, ſome of their properties are very different. Thus water extinguiſhes the one, and conducts the other. Freezing is not retarded by electric matter, tho accumulated in large quantities. A bar of iron may be heated at one end, while it is cold at the other, but every part of it is electrified equally.

PROP. VI.

When electric matter ſtrikes thro a body, if the body contains phlogiſton, or pure fire, in a certain quantity, and if the electric matter is in a certain quantity, the body will be dilated, melted, or inflamed; and tho the proportions of the phlogiſton, of the pure fire, and of the electric matter ſhould be varied, the ſame effects will follow.

PROP. VII.

By the electric ſhock, the calces of metals may be reſtored to their metalline ſtate; and ſmall pieces of gold and ſilver may be calcined; ſome of the particles being converted into a tranſparent glaſs, and ſome tinged with various colours.

Of the experiments from which it is conjectured by ſome that electric matter partakes of the nature of the vitriolic acid; and by others, of the phlogiſton, &c.

SECT. III.

Of the attraction and repulſion of electric matter.

PROP. I.

The particles of electric matter are ſtrongly attracted by conducting bodies; but they mutually repel each other.

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PROP. II.

If the ſurface of a body on which electric matter is accumulated be round, large, and ſmooth, it will continue electrified till the ſurrounding bodies attract the electric matter. If it has an edge, or angle, the electric matter will paſs off ſpeedily. If it has a ſharp point or points, it is with great difficulty that it can be electrified at all.

PROP. III.

Pointed non-electrics ſerve to draw off, as well as to throw off, electric matter.

PROP. IV.

When electric matter is drawn off by non-electric points, it is ſlowly, and without noiſe. When it is drawn off by round or blunt bodies, it is ſuddenly, and with an exploſion or ſnap.

Cor. A great quantity of electric matter may be drawn off by a ſharp wire, without producing any ſenſible effect.

PROP. V.

If electric matter paſſes thro a body or bodies, which are good conductors, and the parts of which are in cloſe contact with each other, its motion ſeems to be inſtantaneous, tho the diſtance be very great: but if the bodies are not good conductors, or if they are at ſome diſtance from each other, its velocity may be meaſured.

PROP. VI.

An increaſe of ſurface makes a body capable of receiving a greater quantity of electric matter; and it would ſeem in proportion to the ſurface.

PROP. VII.

Excited non-conductors, or electriſed conductors, retain their electric matter, till conductors that have leſs are brought near them, and then it is equally divided.

SECT. IV.

Of the elective attraction of electric matter.

PROP. I.

The following bodies attract, or conduct, electric matter according to the order in which they ſtand, the moſt powerful being firſt.

Claſs I. Iron, braſs, copper, ſilver, gold, lead.

Claſs II. Biſmuth, nickel, zinc, antimony, arſenic, cobalt.

Claſs III. Metallic ores, ſemi-metallic ores.

Claſs IV. Charcoal, water, oil of vitriol, ſpirit of wine, animal bodies, moiſt vegetables, flame.

Claſs V. Common earth, common ſtone, glue.

PROP. II.

The following bodies are placed according to their non-attracting, or non-conducting qualities; the firſt in order being the moſt perfect non-conductors.

Claſs I. Diamond, ſapphire, carbuncle, opal, amethyſt, beryl, cryſtal, glaſs, and all vitrifications.

Claſs II. Venice talc, garnets, rubies, topazes, hyacinths.

Claſs III. Amber, ſealing wax, baked wood, porcelane veſſels, ſilk, air, carnelians, reſins, ſulphur, ſalts, ſugar, pitch, gums, jett, oils, aether, marble.

Claſs IV. Down, wool, feathers, hair, parchment, horns, bones. whalebone, ſhells.

Claſs V. Dry willow, mahogany, aſh, elm, oak, boxwood, ebony.

Of the differences in the conducting and non-conducting powers of the bodies in the above claſſes, and genera; and in their ſpecies; according as they are more or leſs pure, and according to the circumſtances taken notice of in the propoſitions of the firſt ſection.

PROP. III.

When electric matter paſſes thro a body or bodies, and comes in its paſſage to a body or bodies, the conducting powers of which are different, it will run thro that body which is the moſt perfect conductor, tho its courſe ſhould be much longer. But if it is to go thro a homogeneous body, or thro bodies that are equally good conductors, it will take the ſhorteſt paſſage.

Cor. 1. Hence, and from Prop. V. Sect. III. electric matter may be made to paſs thro the ſwifteſt running river; or thro the ocean tho violently agitated.

Cor. 2. A man may hold a piece of metal in his hand, and a vaſt quantity of electric matter may paſs thro the metal, while he will not receive the leaſt ſhock.

SECT. V.

Of electrifying bodies poſitively and negatively.

PROP. I.

While a conducting body is in the common ſtate, if a cork ball, or any light piece of conducting matter, which is in the common ſtate, is brought near it, the ball will neither attract nor be attracted. If the ball is in the minus ſtate, it will be attracted. If in the plus ſtate, it will firſt be attracted and then repelled.

PROP. II.

If a conducting body is in the negative ſtate, and the ball is in the common ſtate, the ball will be attracted. If the ball is in the ſame minus ſtate, it will not be attracted: but if two balls are in the minus ſtate, they will often recede from each other by the attraction of the ſurrounding bodies. If the ball is in the plus ſtate, it will be attracted and afterwards repelled, if the quantity given is more than ſufficient to put them both in the common ſtate.

PROP. III.

While a conducting body is in the poſitive ſtate, if the ball is in the common ſtate, it will firſt be attracted

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and then repelled. If the ball is in the minus ſtate, it will be attracted and then repelled, if the quantity received by the ball is more than ſufficient to put it into the common ſtate. If the ball is in the plus ſtate, it will be repelled, if the plus ſtates are equal; if unequal, it will firſt be attracted and then repelled.

PROP. IV.

Amber, roſin, ſulphur, and ſealing wax when excited, give the appearances of being in the minus ſtate.

PROP. V.

Vitreous bodies with a ſmooth ſurface, give the appearances of being in the plus ſtate; and vitreous bodies with a rough ſurface, of being in the minus ſtate; this ſmoothneſs and roughneſs being relative to the rubbers.

Cor. 1. No electric matter will be obtained from wax, and from glaſs with a ſmooth ſurface which communicate with each other, if both are equally rubbed, and if all circumſtances are equal.

Cor. 2. If the poliſh is taken off part of a glaſs tube, the plus and minus ſtates may be produced by the ſame ſtroke of the ſame rubber; and if ſmoothneſs is given again to the unpoliſhed part of the tube by chalk, &c. the whole tube will electrify plus in the ſame way as if the poliſh had never been taken off it.

Cor. 3. By not attending to theſe circumſtances, to Prop. II. and III. of Sect. I. and to Prop. IV. of Sect. II. many good electrical machines become uſeleſs.

PROP. VI.

White ſilk when excited electrifies plus, like glaſs with a ſmooth ſurface; and black ſilk when excited, electrifies minus, like glaſs with a rough ſurface.

SECT. VI.

Of the Leyden phial.

PROP. I.

At the ſame time that the wire and the inſide of the phial are electrified plus, its outſide is electrified minus, and in exact proportion.

PROP. II.

Both ſides of the phial cannot be reſtored to the ſame ſtate by inward communication or contact of the parts. It muſt be done by a communication formed without by ſome conducting body touching them both at the ſame time, or touching them alternately. In the firſt caſe, both ſides are reſtored to the ſame ſtate, with the greateſt quickneſs; in the laſt caſe, by degrees.

Cor. A phial cannot be electrified that is foul or moiſt on the outſide, from the cork or wire all along to the coating.

PROP. III.

As no more electric matter can be thrown into the inſide of the phial, when all is driven from the outſide, ſo in a phial that is not electriſed, none can be thrown into the inſide, when none can eſcape from the outſide;

and in a phial that is electriſed, little can be drawn from the inſide, unleſs an equal quantity can at the ſame time get in at the outſide.

PROP. IV.

The ſhock to the nerves of the perſon who holds the phial and touches the wire, is occaſioned by the ſudden paſſing of the electric matter thro his body in its way from the inſide to the outſide of the phial; or by its acting upon the electric matter contained in the body.

PROP. V.

The phial may be electrified thro the coating as well as thro the wire, and there will be the ſame exploſion and ſhock to the nerves if the electrified phial is held in one hand by the wire, and the coating is touched by the other, as when held by the coating and touched by the wire. But a phial electrified thro the wire, will give the exploſion thro the wire; and one electrified thro the coating, will give the exploſion thro the coating, and in no other way.

PROP. VI.

If there is the leaſt crack or fiſſure in the glaſs of the Leyden phial, it cannot be electrified or charged.

Cor. 1. If the glaſs is cold, the electric matter cannot be forced thro it without cracking it, or deſtroying the cloſe contiguity of its parts. If the glaſs is hot, the electric matter will go thro it; but then it is not the Leyden phial, becauſe incapable of giving a ſhock.

Cor. 2. Tho electric matter ſhould mix with the effluvia of an odoriferous, or medicinal, non-electric body within an excited glaſs globe, the effluvia cannot come to the prime conductor, and ſo to a perſon that is inſulated.

PROP. VII.

The whole force of the phial and power of giving a ſhock is in the glaſs itſelf, the conductors in contact with the two ſurfaces ſerving only to give to, and receive from, its ſeveral parts.

Cor. 1. Tubes or globes cannot be excited if they are moiſt, or coated with good conductors in the inſide.

Cor. 2. Hence, and from Prop. VI. Sect. III. it is not the abſolute quantity of non-conducting matter contained within the phial; but, all things being equal, the quantity of its ſurface that makes it capable of giving a greater ſhock.

Cor. 3. The properties of the Leyden phial may be given to a pane of glaſs, or to a plate of roſin, by coating it, and by accumulating electric matter upon one of its ſides in the ſame manner as upon the ſide of the Leyden phial; and a quantity of air may be made to give a ſhock in like manner.

Cor. 4. The phial will retain its charge a long time, if placed in dry air; or if its wire is covered by a non-conducting body.

SECT. VII.

Of the coheſion of bodies by electric matter.

PROP. I.

White or black pieces of ſilk, when excited, adhere to bodies with broad ſmooth ſurfaces, tho ſuch bodies ſhould not be electrified.

PROP. II.

Two pieces of ſilk, one white, and another black, when excited, and allowed to come together, will adhere with a force which will require from one ounce to ſeveral pounds to ſeparate them. If, while adhering, two ſimilar pieces of ſilk more highly electrified are ſeparated from one another and preſented to the former, their coheſion will be deſtroyed, and each of the ſecond pieces of ſilk will catch hold of, and carry away with it, that of its oppoſite colour. If the two laſt pieces of ſilk are excited equally with the firſt, the coheſion of the firſt pieces will be weakened, but not deſtroyed, and all the four will cohere, forming one maſs. If the ſecond pieces of ſilk are but weakly excited, the coheſion of the firſt pieces will be but little impaired, and the coheſion of the whole maſs will be ſmall in proportion.

PROP. III.

If two panes of glaſs are put together, if their external ſides are coated, and if the one is electrified plus, and the other minus, there will be a ſtrong coheſion between them.

SECT. VIII.

Of non-conductors which are excited by heat.

PROP. I.

The lapis tourmalenſis may be excited by heating it without any friction; and one of its ſides A, will be in the plus ſtate, while the other ſide B, will be in the minus. This has been obſerved to happen when the heat of a room has been raiſed only one degree; but it may eaſily be produced by plunging the tourmalin in hot water and drying it afterwards.

PROP. II.

The tourmalin not being electrical, will become ſo by cooling; but with this difference, that the ſide A will be in the negative ſtate, and the ſide B in the poſitive.

PROP. III.

If the tourmalin, in a non-excited ſtate, be heated equally, and ſuffered to cool again, without either of its ſides being touched; A will be poſitive, and B negative, the whole time of the increaſe and decreaſe of its heat. But if the heat is not equally diffuſed, as by the ſudden approach of a hot iron, the above appearances are not always the ſame.

PROP. IV.

By friction, either ſide of the tourmalin may be

brought into the plus ſtate; and both may be made ſo at the ſame time.

PROP. V.

The electrical properties of the tourmalin may be deſtroyed by fire.

PROP. VI.

If one piece is cut from the poſitive end of the tourmalin, and another from the negative end, the pieces will have the ſame properties which they had before they were cut off. But the oppoſite ſides of each piece will be plus and minus, according to the general property of the tourmalin; and the remaining part will have the ſame properties which it had when entire.

PROP. VII.

The Braſil topaz has the electrical properties of the tourmalin; and ſome other precious ſtones reſemble it in this reſpect.

PROP. VIII.

A thin glaſs electrified and hermetically ſealed, will be excited by altering its temperature.

From ſome appearances it would ſeem that air may be electrified plus and minus by heat alone.

SECT. IX.

Of the electrifying qualities of ſome animals.

PROP. I.

If the gymnotus of Surinam is touched with the naked finger, or with a piece of metal, the arm is inſtantly ſhocked as high as the elbow. If touched with the foot, the ſhock reaches as high as the knee. This fiſh poſſeſſes the ſame power at all times, and in all ſtates of the weather, whether it is in the ſea, or in a veſſel of water, and of whatever materials the veſſel is made. Every part of its body is capable of giving the ſhock, but eſpecially the tail; and when it is in motion in the ſea, the ſhock is tranſmitted to the diſtance of fifteen feet.

The anguilla tremula, and torpedo, have ſimilar properties; but tho the facts concerning them and the gymnotus are well atteſted, and ſeem to be electrical; yet for want of accurate obſervations, nothing that is ſatisfactory can be ſaid.

PROP. II.

The hair upon the heads of many infants, and upon ſome grown perſons, becomes highly electrical by friction. In the ſame way the backs of ſome cats will yield a quantity of electric matter ſufficient to inflame ardent ſpirits. A ſimilar property in a ſmall degree belongs to ſome other animals.

PROP. III.

The bodies of ſome men are much fitter for exciting electric matter than the bodies of others; and there are ſome few inſtances of men to whom the electric ſhock could not be given.

SECT. X.

Of electrifying magnets and iron.

PROP. I.

The magnetic power and electric matter may ſubſiſt together in the ſame body. The accumulation of electric matter affects not the ſtrength of the magnetic power in ſuſtaining weights, or in acting upon magnetic needles; abſtracting from the attractive or repulſive power of the electric matter, which will act upon the needle like any other conducting body, as explained in Sect. III.

PROP. II.

A ſtrong electric ſhock frequently gives polarity to needles. If the needle, when ſtruck, lies eaſt and weſt, the end entred by the electric matter will point north. If it lies north and ſouth, the end that lay towards the north will point north, at whatever end the electric matter entred. The polarity given is ſtrongeſt when the needle lies north and ſouth, and weakeſt when it lies eaſt and weſt.

PROP. III.

By an electric ſhock, the poles of a magnetic needle are ſometimes reverſed; and ſometimes the magnetic power is totally deſtroyed.

SECT. XI.

Of electrifying living vegetables and animals.

PROP. I.

If vegetables are electrified, their growth is often quickened.

PROP. II.

By electrifying animals when inſulated, and without giving them any ſhock, their pulſe is commonly quickened, and their perſpiration increaſed.

PROP. III.

Obſtructions are often removed, and diſeaſes ſometimes cured, by electric ſhocks.

The ſucceſs in curing diſeaſes by electrifying the patients, or by giving them ſhocks, has been inconſiderable. Perhaps it would have been otherwiſe, if the following rules had been obſerved. The ſhocks ſhould be very ſmall at firſt, and ſhould never be ſo great as to give terror to the patient. In moſt caſes they ſhould be gentle, but frequent. They ſhould be given to palſied limbs without paſſing thro the vitals; and from ſmall beginnings, they may be greatly encreaſed. Long perſeverance, accompanied with proper medicines, ſeems to be neceſſary in order to make a fair trial.

PROP. IV.

Animals may be killed by the electric ſhock, if given in a great degree, and thro the vitals.

SECT. XII.

Of meteors and thunder.

PROP. I.

When electric matter is made to fall upon ſuch earth as the ignis fatuus is commonly ſeen upon, it produces the ſame appearances.

PROP. II.

The prodigies that have been ſeen on the ſpears and helmets of ſoldiers, the comozants on the maſts of ſhips, and the lambent fires on the tops of ſteeples, may be repreſented by electric matter.

PROP. III.

If electric matter is made to paſs thro a rare atmoſphere with ſome moiſture interſperſed, it reſembles what is called a ſhot ſtar; if thro a very rare atmoſphere, it will dart from place to place with the appearance of the aurora borealis.

PROP. IV.

The moſt remarkable phaenomena of lightning are the following.

Its colour is often whitiſh; and it moves in a crooked direction. It is conducted by ſome bodies, and not by others. It ſcorches ſome, burns others, and fuſes metals. It diſſipates, or ſtrips off gilding, without hurting the paper, or painted wainſcot, to which it is fixed. It makes holes in ſome bodies, and rends others. It gives polarity to iron, reverſes the poles of magnetic needles, or deſtroys the magnetic power entirely. It ſometimes deprives men of ſight, and ſometimes kills them ſuddenly. It ſtrikes the higheſt and moſt pointed bodies; and is often accompanied with the noiſe called thunder.

PROP. V.

If electric matter is made to paſs in large quantities from one conductor to another, it reſembles lightning in its colour. If it is drawn from an irregular body at ſome diſtance, or thro a ſpace in which conductors are diſpoſed in an irregular manner, it has an angular direction.

PROP. VI.

Lightning and electric matter are conducted or not conducted by the ſame bodies, ſee Sect. IV. and they inflame the ſame bodies, and fuſe metals; ſee Sect. II. Prop. VI.

PROP. VII.

By a ſhock of electric matter, gold leaf may be diſſipated, or fuſed, without burning the paper or painted boards with which it is in contact. Holes may be ſtruck thro a quire of paper; and pieces of wood may be ſhivered.

PROP. VIII.

That the effects of electric matter upon magnets are the ſame as the effects of lightning above mentioned, appears from Sect. X.

PROP. IX.

Animals are ſometimes ſtruck blind by an electric

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ſhock as well as by lightning. And they may be killed, if it is large, and paſſes thro their vitals. Sect. XI. Prop. IV.

PROP. X.

A pointed iron rod erected on buildings, and communicating thro non-conductors, or leſs perfect conductors, with the moiſt earth, will either prevent a ſtroke of lightning altogether, or conduct it into the earth ſo as that the building will receive no harm. Sect. III. Prop. III.

A wire may be fitted up in ſhips, which in the ſame manner, will prevent their being hurt by lightning.

PROP. XI.

If a wire or rod of metal with a ſharp point, is ſupported by non-conductors, and raiſed higher than the neighbouring hills, trees, or edifices, it will be electrified by the thunder clouds which come near it. The Leyden phial may be charged; and every electrical experiment may be performed by it, in the ſame way as with a common electrical machine.

A boy's kite or dragon, with a long wire, may be made to anſwer the ſame purpoſe.

Cautions to be obſerved in erecting thunder rods for the ſecurity of houſes, or for making experiments.

Of the ſecureſt places in the fields, and in houſes againſt the deſtructive effects of lightning.

PROP. XII.

Clouds are often electrified plus or minus, like the bodies on which electrical experiments are made. See Sect. V. They ſeem too to be often plus or minus with regard to the trees, houſes, or hills, to which they give lightning, or from which they receive it.

PROP. XIII.

If electric matter is made to paſs ſuddenly, and in large quantities, from one conductor to another, it produces loud exploſions.

PROP. XIV.

The putrefaction of animal bodies is haſtened by great ſhocks of electric matter.

Of the effects of lightning and electric matter upon fermenting bodies.

SECT. XIII.

Theories of electricity.

Of the different theories of electricity. A review of the experiments which prove the above propoſitions, together with others upon which a theory of electricity is founded.

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MAGNETISM.

SECT. I.

General properties of the magnet.

PROP. I.

THE magnet attracts iron; and no other body whatever, unleſs it has a mixture of iron. The action and reaction of the magnet and iron is mutual and equal.

PROP. II.

There are two parts in a magnet called its poles, one of which turns always towards the north, and the other towards the ſouth, if it has a free motion.

PROP. III.

If two magnets are brought near each other, and have a free motion, they will mutually attract or repel, according to the ſituation of their poles. They will attract when the poles are of a contrary denomination, and repel when of the ſame. But if their magnetic powers are unequal, and they are brought very near each other, they will attract in every poſition.

PROP. IV.

The attraction and repulſion of magnets is not hindered or increaſed by the interpoſition of any body whatever; excepting ſuch as are magnetical, or ſuch as are capable of being made ſo.

PROP. V.

The attraction and repulſion of the magnet ſeems to decreaſe as the ſquares of the diſtances from the reſpective poles increaſe; but this law is ſubject to great variations, from different cauſes.

PROP. VI.

The magnet will communicate all its properties, without any diminution of its own power, to a ſmall piece of iron that is rubbed upon its poles, or brought near them.

Iron acquires and loſes the magnetic power much ſooner than ſteel.

SECT. II.

Of the magnetic compaſs.

Of the magnetic needle. Of the various ways in which it was formerly conſtructed, according as it was uſed at land or ſea.

Of the compaſs and its rhumbs.

Of the beſt ſhape of the needle, beſt cap, ſupport, caſe, and manner of fitting it up.

Of the uſe of the compaſs by ſea and by land.

SECT. III.

Of the declination of the magnetic needle.

PROP. I.

A. D. 1550, the variation at Paris was 8°, 0′ Eaſt.

1580, 11°, 30′ E. 1610, 8°, 0′ E. 1640, 3°, 0′ E. 1664, 0°, 40′ E. 1666, 0°, 0′.

A. D. 1670, 1°, 30′ Weſt. 1680, 2°, 40′ W. 1686, 4°, 30′ W. 1692, 5°, 50′ W. 1700, 8°, 12′ W. 1710, 10°, 50′ W. 1720, 13°, 0′ W. 1726, 13°, 45′ W. 1728, 14°, 0′ W.

PROP. II.

The variation at London A. D. 1576, was 11°, 15′ Eaſt. 1612, 6°, 10′ E. 1622, 6°, 0′ E. 1634, 4°, 5′ E. 1657, 0°, 0′.

A. D. 1665, 1°, 22′ Weſt. 1672, 2°, 30′ W. 1683, 4°, 30′ W. 1692, 6°, 0′ W. 1700, 8°, 0′ W. 1730, 10° ¼ W. 1744, 14° ¼ W. 1756, 15° ¼ W. 1759, about 17° W.

Of the variations in different parts of the earth, and of Dr. Halley's chart.

Of the variations from the year 1700, till the year 1756, collected by Dodſon and Montaine.

PROP. III.

Under the equator, in Long. 40° Eaſt from London, the higheſt variation from 1700 to 1756 was 17° ¼ Weſt, and the leaſt, 16° ½ W. In Lat. 15° North Long. 60° W. the variation was conſtantly 5° E. In Lat. 10° S. Long. 60° E. the variation decreaſed from 17° W. to 7° ¼ W. In Lat. 10° S. Long. 5° W. it increaſed from 2° ¼ to 12° ¾ W. In Lat. 15° N. Long. 20° W. it encreaſed 1° W. to 9° W. In the Indian ſeas, the irregularities were greater; for in the 1700, the Weſt variations ſeemed to be regularly decreaſing from Long. 50° E. to Long. 100° E. but in 1756, the variation decreaſed ſo faſt, that there was Eaſt variation in Long. 80°, 85°, and 90° E. and yet in Long. 95°, 100° E. there was Weſt variation.

Of the importance to philoſophy and navigation of obſerving the variations in different parts of the earth.

SECT. IV.

Of the inclination of the magnetic needle.

PROP. I.

A. D. 1576 the dipping of the needle at London was 71°, 50′. 1653, 72°, 45′. 1676, 73°, 30′ 1728, 73°, 45′.

PROP. II.

The inclination is various in the ſame place, according to the length, weight, nature of the ſteel, and manner of ſuſpending the needle.

PROP. III.

There are tables of the dipping of the needle in a great variety of latitudes and longitudes, but they are generally of little value, becauſe no accurate account is given of the conſtruction of the needle with which the dipping was obſerved.

Of the beſt method of conſtructing the dipping needle, and of making obſervations with it.

Of the uſe of the dipping needle in philoſophy and navigation.